EFFECT OF TWO TYPES OF MOWERS ON CROP DRYING RATE, YIELD AND QUALITY OF ALFALFA (*Medicago sativa* L.)

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Abstract. Disc mowers with conditioner (DC) and drum mowers (DR) are compared to reduce losses due to drying time in forage crop farming. Mowing methods affected the feed quality of the crop. High feed quality has been achieved in both methods, but the main difference was in the effects of the compared methods on productivity and final yield. In particular, the DC method achieved a higher area work efficiency and an economic harvest at the same rate; despite 17% lower energy consumption under the same conditions. In addition, the three-day advantage provided by the 38% lower crop moisture content in the first mow with the effect of the conditioning system increased even more with the impact of the precipitation in the following crops. The study obtained a 34% higher green feed yield in the DC method, which could increase profit by preventing quality losses.
Keywords: *roughage, mower, drying time, yield, quality, number of harvests*

Introduction

Adequate and balanced nutrition is one of the most important factors in the survival of living organisms, especially in health. Especially in animal production, high efficiency and sustainability of production are directly related to nutrition. It is necessary to reduce dry matter losses during harvest and storage as well as to obtain high-yield roughage. Climatic conditions, farm size, plant variety, and mechanization infrastructure have important effects on harvest and storage, which are the main factors that determine the amount and quality of forage production. The negativities in agricultural production, especially insufficient and irregular rainfall, make it difficult to obtain sufficient and balanced yields from meadows and pastures.

Alfalfa, silage corn, vetch, sainfoin, and oat (green grass) are the most widely grown dry grass and green forage plants. Alfalfa has an important place in the production of forage crops in terms of meeting the need for roughage (Özkan, 2020). The cultivation rate of forage crops in the total agricultural area in EU countries is 36% in Germany, 31% in the Netherlands, 30% in Italy, and 25% in France and England (Açıkgöz et al., 2005). In Turkey, the share of forage crops cultivation amount in the agricultural area is 6.1%, and its share in arable land is 12.3% (Tan et al., 2021).

The problems encountered in the drying of forage and the storage of hay cause a decrease in the degree of usefulness in animal production and a decrease in the use of hay. Depending on the harvesting system applied, possible adverse weather conditions in the period between mowing may cause an increase in the moisture content of the crop (Meehan et al., 2011). The fact that the need for quality roughage of animals cannot be met under the current conditions makes it necessary to meet this need with forages such as straw, and husk, which have low feed value. This situation, which does not comply

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with the nutritional physiology of animals, causes low yields and an increase in animal production costs (Alçiçek et al., 2010; Harmanşah, 2018). As much as the amount of roughage production for high-efficiency animal production, it is stated that factors such as forage type, structure, and roughage/concentrated feed ratio are important factors in production (Yılmaz et al., 2020).

Alfalfa, which develops deep, strong roots, is drought and high-temperature tolerant and produces satisfactory yields even at very low precipitation. Alfalfa is not very selective in terms of soil requirements; it grows well in soil pH 6.5-7.5, sandy, well-drained, deep loamy soils, and is relatively salinity tolerant (Undersander et al., 2011; Orloff et al., 2015). Alfalfa can be harvested 3-8 times a year, depending on regional characteristics. Although the yield varies according to the region, climate, and maturity period when alfalfa is harvested, the average hay yield is about 800-1000 kg/da. When harvested towards the end of the maturation period, yield increases, but the nutrient content and digestibility of nutrients decrease. Dry alfalfa contains about 20% protein. This value is very important in animal nutrition (Rade et al., 2019).

A highly efficient, economical, and high-quality product is a must in agricultural production and, therefore, in the production of forage crops. In this respect, shortening the drying time of the crop in the field is one of the factors that increase the yield. Humidity should be between 17-20% in order to obtain an ideal level of the crop. Generally, crops such as alfalfa and meadow grass grew as animal feed require 1-2 days to dry up to 18% moisture content, which is suitable for baling in sunny summer conditions (Bitra et al., 2012). The energy output/input ratio was determined as 8.84% in the compressed vetch+triticale harvesting system, where the seed, fertilizer, and machine input energy had the highest share, respectively (Bibilgi et al., 2019). When deciding on the harvesting method, it is important to choose the method that will shorten the drying time, be the most efficient and economical, as well as keep the biomass losses in the crop at the lowest level. Since the leaf has a higher nutritional value compared to the stem, the loss of leaves at harvest leads to an increase in the fuel quality of the harvested biomass but a decrease in nutrients (Christian et al., 2001). In addition, to yield loss due to leaf loss, stem loss also occurs before and after harvest. It is stated that these changes depending on the cutting height and the characteristics of the harvesting equipment (Huisman, 2003). In general, it is stated that the total machine operating values in the roughage production of the disc mower with conditioning is 10% lower than that of the drum mower (Vurarak et al., 2020). Compared to conventional mowers, it is stated that the drying time of alfalfa is 20-29% lower in machines that perform the mowing-conditioning process together, while there is no significant change in protein content (Kavruk, 1997).

The research was carried out in order to reveal the differences that the harvesting methods will provide in green forage harvesting by comparing the disc mower with conditioning and drum mowers in order to reduce the losses due to the prolongation of the crop drying time, which is an important problem in the production of roughage. For this purpose, firstly, the two methods to be applied were evaluated in terms of the number of harvests and feed yields depending on the crop drying times. Along with the method that provides the targeted production increase, the technical criteria that play a role in the production increase are examined.

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Material and method

Research site

The research was conducted in Mayıslar 1 (M1, point location 40°2'51.00" N, 40°42'29.63" E) and 2 (M2, point location 40°2'56.50" N, 40°42'48.14" E) of a total of 18 ha alfalfa fields are located at the Eskişehir Osmangazi University, Faculty of Agriculture, Sarıcakaya-Mayıslar research and application land (*Figure 1*). Mayıslar, a neighborhood of the Sarıcakaya district, is located in the north of Eskişehir and 40 km from the center. The region, which has a surface area of 375 km^2 with an altitude of 220 m above sea level, shows microclimate characteristics, unlike the Central Anatolia Region. The region has a climate characteristic of a mixture of maritime and terrestrial climate regions. Although not as much as the Mediterranean climate region, the summers are hot and dry, and the spring, autumn, and winter months are warm and rainy. According to the data of 2021, in May, the hottest month was August at 27°C, and the coldest month was the period between January and March at 7°C. The annual average temperature was 15°C. The annual total precipitation is 306 mm, and half of the total precipitation was received in the April-June period (Meteor, 2022) (*Figure 2*).

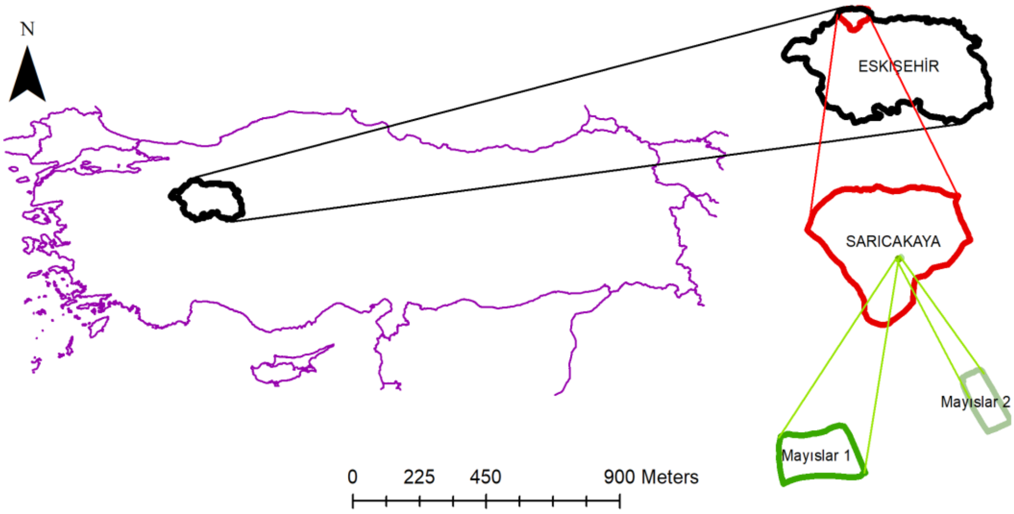

Figure 1. *Location of the research area*

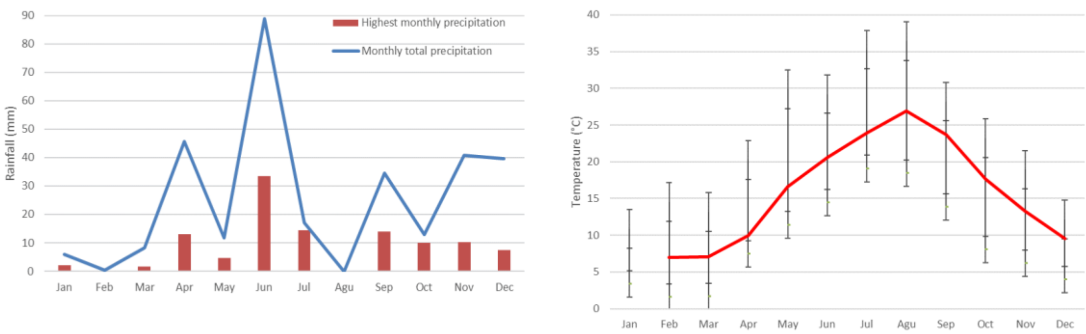

Figure 2. *Climate data of research area for the year 2021*

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Materials

The analysis results of the soil samples taken from 0 - 30 cm depth to determine the soil properties of the area where the experiment is located are given in *Table 1*. According to the soil analysis, the soil of the trial area was determined as loamy, low in organic matter, moderate in lime, high in phosphorus and potassium, free of salt, and alkaline in terms of pH.

Table 1. *Some physical and chemical properties of trial area soils*

	M1	**M2**	**Level**
% Saturation	47	45	Loamy
pH	7.90	7.70	Alkali
EC	3.054	2.601	Light
% Total salt	0.092	0.075	Very low
% Lime ($CaCO_3$)	12.43	13.16	Medium
Organic matter	0.66	0.66	Very low
P_2O_5 (kg ha^{-1})	16.00	16.00	High
K_2O (kg ha^{-1})	1196.00	1196.00	Very high

In the research, a 5-disc mower with conditioning, the M2 plot was mowed by a 2-units drum mower (*Figure 3*, *Table 2*), mowed the M1 plot. The M1 plot is 2.5 ha, and the M2 plot is 1.1 ha. Mirna variety belonging to Alfa Seed Company was used in the research and planted on 17.04.2020. In order to accelerate the drying of the crop after the harvest in the plots, the crop is turned with a 9-arm rotary rake in both methods (*Figure 4*, *Table 3*). Agricultural operations in both plots were carried out with a Deutz-Fahr 65 model tractor.

Figure 3. *Disc mower with conditioner (left) and drum mowers (right) used in the study*

Table 2. *Technical specifications of DC and DR*

Specifications	**DC**	**DR**
Number of disc	5	2
Overall width (mm)	3900	2750
Weight (kg)	735	380
Power requirement (HP)	60	55
Number of blades (pieces)	10	12
PTO speed (rpm)	540	540

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Figure 4. *Nine-armed rotary rake*

Table 3. *Technical specifications of rotary rake*

Working width (mm)	3300
Road position width (mm)	2100
Height (mm)	1000
Length (mm)	3550
Weight (kg)	330
Power requirement (kW-HP)	14-20
Number of arms (pieces)	9
Number of springs per arm (pieces)	3
Wheel dimensions	2 × (15×6-6PR)

Methods

Plant samples were taken randomly from one m² area at 5 points from the plots where each mowing method was applied at mowing times (*Figure 5*). The first weighing of the samples taken for determining crop moisture and green roughage yield was made under field conditions. Green roughage yield (kg ha^{-1}) was calculated from the obtained values. Moisture content (%), green and dry roughage yield (kg ha^{-1}), crude ash ratio (%), crude protein ratio (%), and crude protein yield (kg ha^{-1}) parameters were determined from the plant samples labeled in the trial area, and a comparison of the two methods was made.

The fuel consumption of the methods was measured with a fuel meter. The mowing height of alfalfa was set as 6 cm, and the working speed was determined by the chronometer method as the distance traveled per unit of time. In addition, the operating speeds of the machines in the area were also determined, and the productivity (ha h^{-1}) was calculated by considering the networking time within the adequate working time.

The harvests were made at 10% flowering (flowering beginning). In autumn, 130 kg ha^{-1} of potassium fertilizer was applied. During the vegetation period, no situation required using any pesticides. During the implementation of the project, no irrigation was carried out before the first mow. In the next mowing, approximately 400 mm of irrigation water was given with 16 times (1, 3, 8, 3, 1, respectively) sprinkler irrigation until the soil reached the field capacity. The maximum irrigation was carried

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out eight times in August when the average temperature was the highest at 27°C, and there was no precipitation. In July and September, when the average temperature was 26.8 and 20.3°C, and the average precipitation of 17 and 34.5 mm was received, three times irrigation was applied.

Figure 5. *Harvested plots and crop sampling*

In order to determine the dry weight of the alfalfa obtained within the scope of the study, they were dried at 55°C for 96 hours, then kept for 24 hours, weighed, and recorded. After the crop samples were ground to pass through a 1 mm sieve, dry matter (DM), crude ash (CA), and crude protein (CP) analyzes were made (AOAC, 2006). In addition, ADF (Acid Detergent Fiber - cellulose, lignin) and NDF (Neutral Detergent Fiber - cellulose, hemicellulose, and lignin) analyses, which are the criteria determining the digestibility of cellulose in roughage, were also evaluated as factor in comparison (Van Soest et al., 1991). Dry matter digestibility (DMD) value was calculated with *Equation 1* depending on the ratio of ADF found in the feed, and the dry matter consumption (DMC) value was calculated with *Equation 2* depending on the ratio of NDF found in the feed. The Relative Feed Value (RFV, Rohweder et al., 1978) used to determine the feed quality was calculated using the DMD and DMC data using the *Equation 3* (Van Dyke et al., 2000). The quality of the calculated RFV was determined by comparing the intervals in the table below (*Table 4*).

$$\text{DMD (\%)} = 88.9 - (0.779 \times \text{\% ADF}) \quad \text{(Eq.1)}$$

$$\text{DMC (\% CA)} = 120 / (\text{\% NDF}) \quad \text{(Eq.2)}$$

$$\text{RFV} = (\text{DMD} \times \text{DMC}) / 1.29 \quad \text{(Eq.3)}$$

The significance of the difference between the green roughage yields obtained from the two different mowing methods applied in the study was determined by the t-test. The effectiveness of the factors determining the feed quality was evaluated by analysis of variance (ANOVA F-test). Duncan's multiple comparison methods established the relationship between the characteristics decisively.

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Table 4. *Quality parameters based on RFV*

RFV	Quality
> 151	High
125-151	1
103-124	2
87-102	3
75- 86	4
< 75	5

Results

In the application area, although the weight of the machine used in the DC method is approximately twice that of the DR method, the energy requirement was measured as 253.4 MJ h^{-1} in both methods at equal working speeds of 8.5 km h^{-1}. However, due to the high working width of the machine used in the DC method, the field-based energy requirement was determined as 191.45 MJ ha^{-1}, and that of the DR method was determined as 230.36 MJ ha^{-1} (*Table 5*).

Table 5. *Technical data obtained in the research*

Specifications	DC	DR
Working width (mm)	2100	1650
Harvested area (ha)	2.5	1.1
Harvest time (min.)	113	61
Energy requirement (MJ ha^{-1})	191.45	230.36
Work efficiency (ha h^{-1})	1.33	1.1
Mean working speed (km h^{-1})	8.5	8.5

During the research process, six mowings were done in the DC and five in the DR method (*Table 6*). Two days after the first mow, the crop in the plots was turned with a rotary rake. The crop in the plot mowed by the DC was baled at 20-22% moisture content on May 11, three days after the mowing date. Since the crop moisture in DR plots on the same date was between 28-30%, it was turned again on May 13 and baled on May 14, three days after the DC.

The moisture difference between methods caused the crop swath and bale dates to differ from the first mow in the DR method. The moisture content differences between the methods create a risk that may lead to more delays and significant losses in case of possible rain or strong wind conditions. 14.4 mm of precipitation was received on 7 July in the DR method, which delayed the baling time by five days. Likewise, there were two more delays in the DR method due to the precipitation of 34.5 mm between 10-20 September and 26.3 mm between 12 October and 5 November. On the one hand, the humidity differences created by the mowing methods on the crop after the harvest; on the other hand, the delays in the crop development and drying times due to the rainfall in between caused less mowing in the DR compared to the DC method.

In total, 18.2 t ha^{-1} higher green roughage yield was obtained in the DC, which was applied with one more mow (*Table 7*), and this difference between the methods was found to be statistically significant ($p < 0.01$) (*Table 8*).

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Table 6. *Application dates on trial plots*

Method	Mow date	Swath	Bale
DC	8 May 2021	10 May 2021	11May 2021
	27 Jun 2021	29 Jun 2021	1 Jul 2021
	30 Jul 2021	1-2 Aug 2021	3-4 Aug 2021
	2 Sep 2021	4 Sep 2021	6 Sep 2021
	12 Oct 2021	15 Oct 2021	17 Oct 2021
	25 Nov 2021	30 Nov 2021	6 Dec 2021
DR	8 May 2021	10-13 May 2021	14 May 2021
	5 Jul 2021	6-9 Jul 2021	11 Jul 2021
	15 Aug 2021	16 Aug 2021	17 Aug 2021
	23 Sep 2021	24 Sep 2021	26 Sep 2021
	5 Nov 2021	10 Nov 2021	15 Nov 2021

Table 7. *Green roughage yields (kg ha^{-1}) obtained depending on the mowing times in the methods*

Mowing times	DC	DR
1	17095.24	17042.42
2	15647.62	12565.71
3	13885.71	10772.38
4	10739.05	7516.19
5	8030.48	6127.62
6	6824.76	0.00
Total	72222.86	54024.32

Table 8. *T-test evaluation chart*

DC - DR	Differences		t	Importance
	Average	St. Deviation		
Green roughage yield	3033.09	560.13	5.415	0.000

According to the results of the research, it was found that the mowing times affected the nutrient composition of the alfalfa (P<0.00), whereas the mowing method was ineffective (P>0.05). The amount of DM gave the lowest value in the first mow and the highest value in the last (P<0.000). RA content was affected by mowing times and interaction, and the RA values of alfalfa obtained in the first, fourth, fifth, and sixth mows were higher than those obtained in the second and third mows (<0.000). The fifth mowing has the highest CP content, while the second, third, and sixth mowing DC methods determined the lowest CP content (<0.000). While the ADF and the NDF content were found to be higher in the second and third mows than the others were, and in the fifth and sixth mows, the lowest (<0.000) (*Table 9*).

The effects of the factors examined in this study on DMD, DMC and RFV are given in *Table 10*. Accordingly, as a result of the calculation made using DMD and DMC values, the highest NYD was obtained in the last mows, followed by the fourth, third, first, and second mows, respectively (P<0.000).

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Table 9. *Nutrient composition of clover (%) and cell wall components (%) at different mowing times according to the methods*

Method	Mowing times	DM	CA	CP	ADF	NDF
DR	1	21.28	10.98a	19.66	35.23	43.77
	2	29.32	9.58b	17.44	42.52	48.56
	3	26.27	8.92c	16.86	41.91	47.09
	4	29.89	11.34a	20.46	32.09	41.70
	5	26.66	11.10a	20.72	32.46	38.41
DC	1	20.86	11.40a	19.83	36.99	44.76
	2	25.65	9.93b	17.58	41.66	49.63
	3	27.36	9.81b	17.41	41.12	47.97
	4	30.01	10.83a	18.92	35.79	44.41
	5	27.74	10.93a	21.12	33.28	37.39
	6	25.07	11.19a	17.01	21.27	26.24
Method	DR	26.67	10.38	19.03	36.84	43.90
	DC	26.32	10.58	18.97	37.77	44.83
Mowing times	1	21.07b	11.19a	19.74ab	36.11b	44.26bc
	2	27.49a	9.76b	17.51c	42.09a	49.09a
	3	26.81a	9.37b	17.14c	41.51a	47.53ab
	4	29.94a	11.08a	19.69ab	33.94b	43.05c
	5	27.16a	11.01a	20.92a	32.87b	37.90d
	6	25.07a	11.19a	17.01c	21.27c	26.24e
MSE		0.539	0.102	0.195	0.756	0.745
P value						
Method		0.709	0.135	0.827	0.413	0.392
Mowing times		0.000	0.000	0.000	0.093	0.000
Method × Mowing times		0.464	0.010	0.089	0.677	0.872

MSE: Mean standard error; a, b, c, d: Statistical difference between the groups (P<0.05)

Table 10. *DMD, DMC and RFV of alfalfa at different mowing times according to the methods*

Method	Mowing times	DMD	DMC	RFV	RFV Quality
DR	1	61.46	2.75	130.93	1.
	2	55.78	2.48	107.64	2.
	3	56.25	2.57	112.14	2.
	4	63.90	2.89	143.12	1.
	5	63.61	3.13	154.43	High
DC	1	60.09	2.69	125.26	1.
	2	56.45	2.43	106.82	2.
	3	56.87	2.53	111.41	2.
	4	61.02	2.73	129.97	1.
	5	62.98	3.24	158.21	High
	6	72.33	4.57	256.24	High
Method	DC	60.20	2.76	129.65	1.
	DR	59.48	2.72	126.33	1.
Mowing times	1	60.77b	2.72cd	128.09c	1.
	2	56.11c	2.46e	107.23d	2.
	3	56.56c	2.55de	111.77d	2.
	4	62.46b	2.81c	136.55c	1.
	5	63.29b	3.19b	156.32b	High
	6	72.33a	4.57a	256.24a	High
MSE		0.589	0.048	3.211	
P value					
Method		0.413	0.532	0.439	
Mowing times		0.000	0.000	0.000	
Method × Mowing times		0.677	0.814	0.765	

MSE: Mean standard error; a, b, c, d: Statistical difference between the groups (P<0.05)

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Discussion

The DC and DR methods considered in the research harvest are according to the knife cutting system, which is the same mowing technique. Although the mowing technique is the same, the number of cutting units, their dimensions, the placement of cutters on the chassis, revolutions per second, the width of the mower, etc., several design parameters such as also bring about differences between the business achievements of the machines. Although the machine weight used in the DC method is twice as heavy as the machine used in the DR method and the hourly energy requirements are equal at the same speed stage, 17% lower unit area energy consumption has been realized due to the high work efficiency of the DC method. On the other hand, when the crop obtained after mowing is evaluated in terms of moisture values, a lower crop moisture content of up to 38% was determined in the DC method at the first mowing date. The three-day difference in removing the crop from the field in the first mowing period increased even more in the subsequent mowing periods with precipitation, resulting in one more mowing in the DC method. In studies on the subject, it is stated that disc mowers with conditioning significantly accelerate the drying time of the crop (Greenlees et al., 2000; Shinners, 2008). One more mowing resulted in 34% more crops being taken under the study conditions.

The economic value of forage crops culture is seen especially in animal production issues. High quality, efficient animal production will only be possible using roughages with high nutritional value in animal production. The nutritional composition of feed raw materials that optimize animal performance and adequately meet the animal's nutritional requirements is determined by evaluating the chemical composition (NRC, 2001). Methods of assessing the nutritional value of individual feeds are essential. The chemical composition and nutrient availability vary both within and between the feed ingredients, and this change can be reflected in the hay quality.

Feed quality is directly affected by factors such as soil, climate, fertilization (Kutlu, 2008), mowing time (Sezmiş et al., 2020; Gökkaya et al., 2021) and method (Hatipoğlu et al., 2020). However, while the mowing time affects the parameters studied in the research, the mowing method has not been affected significantly. The mowing method does not make a difference in the chemical composition, and the relative feed value of alfalfa may be that both methods work with the blade-cutting system.

DM indicates the number of nutrients available to the animal in a given feed. In other words, nutrients (energy, protein, minerals, and vitamins) are found in the dry matter part of the feed. In the study, the amount of alfalfa DM obtained in the first mow (21.07%) was lower than the other mows (second, third, fourth, and fifth mows was found to be 27.49, 26.81, 29.94, 27.16, and 25.07%, respectively). Ünalp (2004), on the other hand, reported that the highest first mow (23.82%) and the lowest fifth mow (20.17%) in terms of DM content at the beginning of flowering. This difference between studies is based on seed type, plant type, soil, climate, etc. may be caused by factors. Considering that the dry matter content of the alfalfa plant is between 19-30% (Ünalp, 2004; Kır et al., 2008; Ayaz, 2010), all the alfalfas obtained in the study are DM regardless of the mowing method and time. It can be considered good quality in terms of dry matter content (21.28% - 30.01%), which shows that alfalfa has a high feed potential.

Feed raw ash contents, which are a criterion indicating the rate of meeting the mineral substance needs of farm animals, were found to be higher in first, fourth, fifth, and sixth (DC) mows. CA values detected in all groups were generally compatible with similar studies (Aksoy et al., 2003; Ünalp, 2004). Ünalp (2004) found that the highest CA value is first mowing time (10.95%), while the lowest value is fourth (9.18%).

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Aksoy et al. (2003) determined the CA ratio of alfalfa's first and second mowing as 9.33 - 10.79%, respectively.

In the studies, it is emphasized that the protein content and quality of alfalfa do not vary much between varieties, and the mowing time and the annual number of mowings are necessary (Maurie's, 2004; Orloff et al., 2007; Putnam et al., 2008; Veronesi et al., 2010). The feed CP contents mowing methods did not affect the study. However, the highest values were obtained at 20.92% in the fifth mow, and the lowest was obtained in the second, third, and sixth mows, with 17.51%, 17.14 and 17.01%, respectively. The amount of CP in a feed is the most crucial indicator of feed quality (Gillen et al., 1998). A feed with a high protein content is expected to have a high feed value. For microbial activities to occur generally in the rumen, ruminant rations should contain approximately 13% protein, and leguminous hay used in the rations of high milk-yielding animals should contain at least 20% crude protein (Hubbard, 2019). Similarly, according to the HP ratio, Budak et al. (2014) classified the feeds as low 12% and below, medium 15%, and high-quality feed 18% and above. Therefore, regardless of the mowing method, the alfalfa obtained in the study is high-quality roughage.

The relative feed value is calculated by estimating how much the animal can eat based on the digestibility of the roughage dry matter and its consumption capacity. However, animals sometimes perform differently, even when fed roughages with the same RFV. Variations in the digestibility of the NDF fraction could explain these differences. RFV of forage crops can be used as a criterion to meet the nutritional needs of dairy cattle (Undersander, 2003). Salama et al. (2016) compared the feed quality of grasses and legumes. They reported that the RFV grading method of forage crops is highly effective in production for high-yielding dairy cows and young animals.

The amount consumed forage is the primary determinant of animal production in forage-based rations. The digestibility of a feed is negatively related to its ADF content, and its consumption potential is negatively related to its NDF content. When roughage with high NDF content is given to animals with high-energy needs, such as high-yielding dairy cows, it reduces feed consumption as it gives a feeling of satiety. The NDF ratio is an important quality indicator determining how much of the cell wall can be digested (Marsalis et al., 2009). The cellulose, hemicellulose, and lignin that make up NDF are tough to digest in ruminants (Mertens, 2011). To produce high-quality alfalfa grass, the NDF content should be below 40% and the ADF content below 31% (Redfearn et al., 2011; Kazemi et al., 2012). Considering the cutting time in the study, NDF values were determined as 44.26%, 43.05, 37.90 and 26.24 (DC), and ADF values as 36.11%, 33.94, 32.87 and 21.27 (DC) in 1st, fourth and fifth mows, respectively. When these results are evaluated, the NDF and ADF contents of alfalfa obtained in the fifth and sixth mow are at the desired levels in dairy cattle rations. Indeed, Kazemi et al. (2012) reported that high-quality alfalfa should generally contain 19% CP. An indication of the excellent feed value of the fifth and sixth form alfalfa may be that the CP content is the highest in this group. The differences in form are due to climate, harvesting method, different ripening times, etc. may be caused by this factor.

RFV has been used for years to compare the quality of legumes, legumes/grass grasses, and silages. RFV estimates and calculates dry matter digestibility (DMD) of alfalfa from ADF and dry matter consumption (DMC; percent of body weight) from NDF (Jeranyama et al., 2004). RFV continues to be widely used as an index to evaluate the quality, compare feed varieties, and feed prices. Higher RFV values indicate higher feed quality (Jeranyama et al., 2004). CP content of the feed is not considered when calculating RFV, but higher RFV values are generally associated with higher protein (Stallings, 2006). The present results confirm this information. Our 5th and 6th form

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groups with lower ADF and NDF ratios have the highest RFV value, while CP content was higher than the other groups. In light of this information, alfalfa has high forage quality after the fifth mow obtained in the study. In fact, in parallel with the study, Engin et al. (2018) determined the highest RFV in the fifth mow (177.0) and the lowest in the second mow (129.2). The increase in ADF and NDF content in the plant affects RFV negatively. Excellent quality alfalfa grass contains 21-22% CP, less than 28% ADF and less than 35% NDF content, and RFV between 170-180 (Boman, 2017). Considering these criteria, the quality of alfalfa is in excellent class, except for the second and third mows (ANKOM, 2017).

Feed input is the highest cost in animal production (Mavruk, 2017). Concentrated feeds supplied with roughage meet the feed needs of animals. The procurement of concentrated feeds from outside the farm increases the production cost. The production cost is low to the extent that the concentrate feed cost is reduced in feeding animals. The need for quality roughage can only be met from meadow pasture areas and forage crops grown in agricultural areas (Vurarak et al., 2019). It can be ensured that the farms can make an economical production by meeting the concentrated feed deficit with high-quality roughage because forage crops considered roughage are the cheapest food source. For this reason, producing quality roughage plants in animal feeding should be increased and readily available. As a result, the alfalfa grass examined in this study, regardless of the mowing system, can eliminate the quality forage deficit, except for the second and third mows.

Conclusion

Feed quality and production cost, which are among the critical parameters in the production of green feed, which is one of the roughage sources, have a vital share as much as the production amount. For this reason, it is a critical issue in sustainable agriculture that the producers adopt methods that will provide high yields with low production costs. The study found no difference between the two different forms or harvesting methods regarding feed quality indicators DM, CA, CP, RFV, ADF, and NDF. In this respect, both methods can be used in roughage harvesting. On the other hand, the DC method stands out due to its low fuel consumption and high area work efficiency, as well as its positive contribution to the creation of conditions that accelerate the drying of the product after harvest and help the product to start developing earlier in the subsequent development period. This prominent feature of the method is at a level that can increase the product by preventing the harvest and related product losses that can be experienced under similar conditions. As a result, making the necessary arrangements for the assembly of squeezing devices, which have the potential to increase production in roughage production on other conventional type machines where this system is not available, will be an essential step in preventing possible product losses.

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