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Assessment of yield and quality characteristics of alfalfa (*Medicago sativa* L.) cultivars with different fall dormancy rating

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ABSTRACT

This research was conducted to determine performances of seven alfalfa cultivars with different fall dormancy rates in terms of dry matter yield and some quality parameters under Mediterranean conditions throughout the years of 2007-2009. In the study, cultivars were evaluated for dry matter yield (DMY), leaf/stem ratio (LSR), crude protein (CP) content, crude protein yield (CPY), acid detergent fiber (ADF), neutral detergent fiber (NDF), digestible dry matter (DDM) content and relative feed value (RFV). According to average of two year results, there were significant differences among alfalfa cultivars in terms of all characters studied. Mean DMY, LSR, contents of CP, ADF, NDF, DDM and RFV were determined as 18.147 t ha^{-1}, 0.82, 17.4 %, 41.0 %, 49.0 %, 56.9 % and 114. The highest DMY averaged over two years was obtained from cultivar Nimet while lowest one was obtained from Magnum 5. As a dormant cultivar, Magnum 5 was superior in terms of LSR and CP content to the other alfalfa cultivars and it was lower in ADF and NDF content than the others. It was concluded that cultivar Nimet with the highest DMY and CPY yields can be recommended as a non-dormant cultivar for farmers in regions of Turkey with the Mediterranean climate.

Key words: Alfalfa, Fall dormancy, Forage quality, Yield.

INTRODUCTION

Alfalfa **(***Medicago sativa* L.) is one of the most important perennial forage crops in the world and it is used primarily as hay, pasture, or green forage for a wide variety of livestock. It is grown throughout Turkey and has an area of 650110 ha with 15.7 million ton fresh herbage production per year (TUIK, 2016). In the Mediterranean environment, it is possible to successfully grow a wide range of alfalfa cultivars from dormant to non-dormant. Fall dormancy (FD) has a large effect on both yield and quality of alfalfa. Non-dormant cultivars (FD 7-9) yield more, but some producers are growing dormant varieties (FD 2-4) to obtain higher quality herbage. The major factors, which impact the production and feeding value of alfalfa during growth, include growth stage at the time of cutting, leaf/stem ratio, climatic factors, cutting frequency, presence of pests and other environmental factors (Hill *et al*.1988). Many factors have been used to estimate forage quality. Crude protein, ADF, NDF contents and total digestible nutrients are the most useful parameters for predicting animal performance. Fall dormancy is an important indicator of winter hardiness in alfalfa, but so far the relationship among FD, yield potential and quality characteristics of alfalfa varieties have not been assessed in the Southern Anatolia in which the winter months are mild. Therefore, this research was initiated to determine forage production potentials and to evaluate nutritive values of dormant, semi-dormant and non-dormant alfalfa cultivars in the Mediterranean region of Turkey.

MATERIALS AND METHODS

Seven alfalfa cultivars namely Nimet (recently developed and registered by East Mediterranean Agricultural Research Institute), Calfa, Kalender, MA 525HQ, Verdor, MA 414 and Magnum 5 were used as plant material. Cultivars Nimet, Calfa, Kalender, MA 525 HQ and Verdor are all non-dormant cultivars (FD 7-9) while the cultivars Magnum 5 (FD 4) and MA 414 (FD 6) are dormant and semi-dormant cultivars respectively (NAFA, 2014). Field experiment was conducted at the East Mediterranean Agricultural Research Institute, Adana, Turkey (36° 51.675 N, 035° 20.662 E, altitude 14 m from sea level) under irrigated conditions during 2007-2009. The soil type was silty-clay; with organic matter content 2.51%, pH level 7.62, and phosphorus content 87.0 kg ha^{-1} and rich in lime. The mean long-term annual temperature was 18.7°C, the highest and the lowest average temperatures occur in August and January, respectively. Minimum and maximum monthly average temperatures were 6.0-29.0 °C , 8.9-29.8°C in the 2008 and 2009, respectively. During the experimental years, annual average temperatures were 18.4 and 19.3 °C respectively (Anonymous, 2008 and 2009).

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The soil was prepared by ploughing and then firmed with cultivator and harrow. The experiment was arranged in a randomized complete block design with four replications, and the experimental plots were fertilized with 150 kg ha^{-1} of P_2O_5 and 50 kg ha^{-1} of nitrogen before sowing. Seeds at a rate of 2 kg ha^{-1} were sown on 28 October 2007 in rows spaced 20 cm apart within 1.6 m by 5 m. Forage was harvested seven times in each of two production years. Cutting was performed when the majority of plants in the plots reached in the early flowering stage. Parcels were irrigated after each cutting in the growing season. Forage yield was calculated by harvesting the centre of each plot (Six rows and 4 m. length) and weighted. In the first growing season including seven cut, forage samples were taken, leaves and stems were separated, and weighed to determine leaf/ stem ratio. Forage quality was determined at all harvest samples for two growing seasons. A fresh forage sample of about 500 g from each plot was taken and dried at 60 °C and ground mill with 1 mm screen for dry matter estimation and subsamples were taken for chemical quality analysis. Forage crude protein content was estimated by multiplying total N by 6.25 (Anonymous, 1995). The ADF and NDF contents of cultivars were determined by using ANKOM Fiber Analyzer filter bag method (Anonymous, 1997). Digestible dry matter (DDM) content was estimated from ADF by using the fallowing equations adapted from formulas for forages (Schroeder, 1994). DDM=88.9-(0.779xADF %). CP yield was estimated by multiplying total dry matter yield of each cultivar with CP ratios. Relative feed value was estimated from digestible dry matter and dry matter intake (DMI=120/ NDF %). RFV = DDM x DMI /1.29.

Analysis of variance was performed using the MSTAT-C statistical analysis programme, and differences were compared using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Dry matter yield: The means of DMY for the alfalfa cultivars are shown in Table 1. Dry matter yield showed significant differences (P≤0.05) depending on alfalfa cultivars. In the first year of experiment, cultivar Nimet produced the highest (25.805 t ha^{-1}), and cultivar Magnum 5 the lowest yield (20.522 t ha^{-1}). However, DMY of cultivar Nimet was similar with other cultivars except Ma 414 and Magnum 5. Cultivars Nimet and Magnum 5 ranked the first and the last in the second year. Based on average of two years, DMY of cultivars ranged from 20.361 to 25.969 t ha^{-1}. The highest DMY was obtained from the cultivar Nimet with 25.969 t ha^{-1}, and it was significantly different from the other cultivars. Cultivar MA 414 and Magnum 5 produced relatively less DMY, and were significantly different from rest of the cultivars, indicating that dormant and semi dormant genotypes generally had lower mean yield than non dormant genotypes (Marquez-Ortiz *et al*.,1999). DMY results of alfalfa cultivars are consistent with previous research results (Avci *et al*., 2007; Kavut and Avcioglu, 2015).

Leaf Stem Ratio: Analysis of variance indicated that there were significant differences among the cultivars in terms of leaf /stem ratio (Table 2). Cultivar Magnum 5 had the highest leaf/stem ratio (1.08). Cultivar Nimet showed significantly lower leaf/stem ratio than Magnum 5, MA-414 and Verdor while it was on a par with cultivars Calfa, Kalender and MA 525 HQ. The harvested alfalfa crop is made up of stems, leaves, and flowers and each part differs in nutritional value. Strabonovich *et al.* (2015) stated that varieties with higher leaf ratio and leaf surface better quality. The relative weight of leaves and stems is probably the most important determinant of quality for alfalfa. Leaf percentage ranges from about 55 to 65 as a very-high-quality alfalfa (leaf/ stemratio=1.22-1.85), while 35 to 45 percent (leaf/stem ratio= 0.53-0.82) in lower-quality alfalfa (Putnam *et al*. 2008). According to this assessment, while cultivar Magnum 5 and MA 414 (having leaf/stem ratio 1.08 and 0.97 respectively) are in the in middle between good and lower-quality class, the other varieties are in the low quality. Rotili *et al* (1999) also stated that the quality of alfalfa is mainly influenced by leaf to stem ratio and the plant with the leaf / stem ratio of 0.85-1.0 is defined as an ideal plant in terms of quality. Alfalfa leaves have higher nutritive value and intake potential than stems when alfalfa is normally harvested.

Crude protein content: Crude protein content was significantly changed by years and cultivars (Table 2). CP ratios of cultivars ranged from 17.6 to 19.6 % as averaged values of two years. Cultivar Magnum 5 and MA 414 showed significantly higher CP ratios than the other cultivars. Their superiority, in terms of crude protein ratio, suggests that

Table 1: Averaged values of dry matter yield and leaf/stem ratio (LSR) for alfalfa cultivars tested.

Cultivars	DMY (t ha^{-1})			LSR
	2008	2009	Mean	2008
Calfa	25.137 a*	23.564 bc	24.351 b	0.71 d*
Kalender	24.107 a	23.744 b	23.925 b	0.76 cd
MA 525 HQ	24.379 a	23.531 bc	23.955 b	0.75 cd
Verdor	23.906 a	24.091 b	23.999 b	0.80 c
Nimet	25.805 a	26.133 a	25.969 a	0.70 d
MA 414	21.883 b	22.257 c	22.070 c	0.97 b
Magnum 5	20.522 b	20.201 d	20.361 d	1.08 a
Mean	23.677	23.360	23.519	0.82

* Means with the same letter in the same column are not significantly different according to Duncan Test at P≤ 0.05 probability level.

Table 2: Averaged values of crude protein (CP) concentration and crude protein yield (CPY) for alfalfa cultivars tested.

Cultivars	CP (%)			CPY (t ha^{-1})		
	2008	2009	Mean	2008	2009	Mean
Calfa	17.6 b	18.2 c	17.9 bc	4.423 a	4.283 b	4.352 ab
Kalender	17.7 b	18.0 c	17.9 bc	4.248 ab	4.272 b	4.260 b
MA 525 HQ	17.9 b	18.8 b	18.4 b	4.355 a	4.419 b	4.387 ab
Verdor	17.6 b	18.0 c	17.8 c	4.189 ab	4.339 b	4.264 b
Nimet	17.4 b	17.9 c	17.6 c	4.463 a	4.677 a	4.570 a
MA 414	19.6 a	19.3 ab	19.4 a	4.172 ab	4.296 b	4.234 b
Magnum 5	19.4 a	19.7 a	19.6 a	3.946 b	3.976 c	3.961 c
Mean	18.2 B+	18.6 A	18.4	4.256	4.323	4.290

* Means with the same letter in the same column are not significantly different according to Duncan Test at P≤ 0.05 probability level.
+ Means with the same letter in the same line are not significantly different at P≤ 0.05 probability level.

higher CP ratios were related to their dormancy rates. Because, fall dormancy of an alfalfa cultivar has a major effect on the crude protein concentration of dry matter and more dormant varieties were almost always higher in CP content (Putnam *et al.* 2005). The lower mean CP content in 2008 could be due to slightly more mature plants at harvesting time than those in the 2009. CP concentration values determined in the present study are lower than those reported by Kallenbach *et al.,* (2002); Spandl and Hesterman (1997); and Al-Ghumaiz (2012), while they were similar with those reported by Canbolat *et al*. (2006); and Avci *et al*. (2007); and Karayilanli and Ayhan (2016).

Crude protein yield: The highest CP yield was obtained from the cultivar Nimet with the 4.570 t ha^{-1} and it was significantly higher than those of the cultivars Kalender, Verdor, MA 414 and Magnum 5. Cultivar Magnum 5 despite having the highest CP ratio (19.6%) produced lower CP yield (3.961 t ha^{-1}) because of its lower DM yield. Relatively higher total CP yield for cultivar Calfa and MA 525 HQ were largely due to their higher DM yields.

Acid detergent fiber: Significant differences were determined among alfalfa cultivars for ADF content (Table 3). ADF concentrations of alfalfa entries ranged from 38.3 to 40.4 % as two years average. Cultivar Magnum 5 had the lowest ADF concentration and it was statistically different from the other cultivars. Cultivar Nimet had higher (40.4%) ADF concentration than the others, but no significant difference was found among them except Magnum 5 and MA 414. Generally, high yielding cultivars have low values in terms of forage quality. Putnam *et al.* (2005) stated that yield and quality are inversely related and the cultivars highest in yield were found lowest in quality (highest in ADF), and the cultivars lowest in yield were typically the highest quality (lowest in ADF). When considered from this perspective Magnum 5 has come to the forefront as a high quality cultivar. In the previous researches, ADF concentrations for alfalfa were found as 27.2-29.8; 38.5-41.0; 38.6-42.7; 25.2-39.2 by Putnam *et al.* (2005), Avci *et al*. (2007 and 2010) and; Spandel and Hesterman (1997), respectively. In general, it is known that forage quality is strongly related to plant maturity differences at the harvests within a year, cultivars, location etc.

Neutral detergent Fiber: Significant differences (P≤0.05) were determined among alfalfa cultivars for NDF content (Table 3). In the first year of experiment, Magnum 5 had statistically significant lower NDF content (45.2%) than the other cultivars with the exception of the cultivar MA 414. NDF contents of alfalfa entries ranged between 44.5 and 49.4 during the second year. The combined data of the two years indicated that the lowest NDF concentration was obtained from cultivar Magnum 5 while Nimet showed highest NDF content. As in the other basic quality criteria, differences in the NDF ratios of cultivars are probably related to the dormancy ratings of cultivars. Because fall dormancy of a variety is an important predictor of quality. More dormant varieties (FD 1-4) are almost always higher in quality (Putnam *et al.* 2005).

In this study, cultivars Magnum 5 and MA 414 are dormant and semi dormant, respectively while Nimet, Calfa and Kalender are non-dormant cultivars (FD 7-9). Low NDF

Table 3: Averaged values of acid detergent fiber (ADF) and neutral detergent fiber (NDF) for alfalfa cultivars tested.

Cultivars	ADF (%)			NDF (%)		
	2008	2009	Mean	2008	2009	Mean
Calfa	40.0 ab*	38.8 a	39.4 ab	48.9 ab	48.1 ab	48.5 ab
Kalender	40.5 a	39.6 a	40.1 a	50.2 a	48.2 ab	49.2 a
MA 525 HQ	39.6 ab	39.9 a	39.7 ab	48.9 ab	48.2 ab	48.5 ab
Verdor	39.6 ab	39.7 a	39.7 ab	47.9 ab	47.8 ab	47.8 bc
Nimet	40.9 a	40.1 a	40.4 a	49.8 a	49.4 a	49.6 a
MA 414	38.3 bc	38.4 ab	38.3 b	46.9 bc	46.9 b	46.9 c
Magnum 5	36.3 c	37.3 b	36.8 c	45.2 c	44.5 c	44.8 d
Mean	39.3	39.1	39.2	48.2	47.6	47.9

* Means with the same letter in the same column are not significantly different according to Duncan Test at P≤ 0.05 probability level.

Table 4: Averaged values of digestible dry matter (DDM) content and relative feed value (RFV) for alfalfa cultivars tested.

Cultivars	DDM (%)			RFV (%)		
	2008	2009	Mean	2008	2009	Mean
Calfa	57.8 bc*	58.6 b	58.2 bc	110 bc	114 bc	112 cd
Kalender	57.4 c	58.1 b	57.7 c	107 c	112 b	110 cd
MA 525 HQ	58.1 bc	57.9 b	58.0 bc	111 bc	112 bc	112 bc
Verdor	58.0 bc	58.0 b	58.0 bc	113 bc	113 bc	113 b
Nimet	57.1 c	57.8 b	57.4 c	106 c	109 c	108 d
MA 414	59.1 ab	59.0 ab	59.0 b	118 ab	117 b	118 b
Magnum 5	60.6 a	59.9 a	60.2 a	125 a	125 a	125 a
Mean	58.3	58.4	58.4	113	115	114

* Means with the same letter in the same column are not significantly different according to Duncan Test at P≤ 0.05 probability level.

values are desirable and are associated with increased animal intake. Canbolat *et al*. (2006) found that NDF content of alfalfa was 44.7 % and 54.2% at the stage of flowering and late flowering, respectively which were similar with our data. In the previous researches (Avci *et al*. 2007 and 2010; Spandel and Hesterman, 1997), NDF concentrations of alfalfa were found as 46.4-47.3; 45.0-48.7; 39.4-47.8% depending on cultivars and years.

Digestible dry matter content: Significant differences (P≤0.05) were observed among alfalfa entries for DDM concentrations every two years and two years average (Table 4). Based on average of two years, the highest DDM concentration was recorded at the Cultivar Magnum 5, and it was statistically different from the other entries. Cultivars Nimet and Kalender with a DDM content of 57.4 and 57.7%, respectively, showed significantly lower DDM contents than the cultivars Magnum 5 and MA 414. The highest and the lowest DDM contents of cultivar Magnum 5 and Nimet respectively, are mainly due to their highest and the lowest leaf/steam ratios, respectively. As already noted, alfalfa leaves have higher nutritive value and intake potential when compared to stems. Julier and Huyghe, (1997) also stated that digestibility of alfalfa cultivars showed differences as depending on their leaf/stem ratios. The DDM contents determined for alfalfa cultivars in our study were similar to previous reports Avci *et al*. (2007); Canbolat *et al*. (2006).

Relative feed value: Significant differences were determined among the cultivars in terms of RFV. The relative feed values of alfalfa cultivars ranged from 108 to 125. The highest and the lowest RFV were determined in the cultivars Magnum 5 and Nimet, respectively. The reason for significant differences among the cultivars probably come from the large amount of variation in Dry Matter Intake (not shown here) and DDM of the cultivars. Because RFV is an index that is derived from the digestible dry matter content and dry matter intake of the forages. RFV of full bloom alfalfa has a value of 100 and larger values indicate greater overall quality relative to the base of 100. 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 (Kiraz, 2011). According to these index values, Cultivar Magnum 5 is classified as premium, while the rest of cultivars are as good.

CONCLUSION

Results of this study suggest that non-dormant cultivar Nimet with the highest dry matter yield and CP yield when compared with the other cultivars tested, could be recommend for growers in the region. However if the main reason is to obtain high quality herbage, growers can choose dormant cultivars, like Magnum 5, or can choose the higher yielding non-dormant cultivars but cut at earlier stages (pre-bud or mid-bud) accepting some loss of herbage yield.

REFERENCES

Anonymous, (1997). Acid detergent fiber and neutral detergent fiber using ANKOM's fiber analyzer F220/220. Ankom Tech. Corporation Fairport, NY.

Anonymous, (1995). The determination of nitrogen according to Kjeldahl using block digestion and steam distillation. Tecator Application Manual. Sweden.

Anonymous, (2008 and 2009). Regional Meteorology Office, Adana, Turkey.

Avci, M., Cinar S., Kizil.S., Kilicalp N., Hatipoglu, R., Yucel, C., Yucel, H., Aktas A., Gultekin, R. (2007). Research on the hay yields and qualities of some alfalfa cultivars under Cukurova conditions. 7th. Field Crops Congress. Erzurum, Turkey. 281-284.

Avci, M., Çýnar, S., Yücel, C., and Inal, I. (2010). Evaluation of some selected alfalfa lines for herbage yield and forage quality. *JFA & Environment,* .**8,** (3&4): 545-549.

Canbolat, O., Kamalak, A., Ozkan, C. O., Erol, A., Sahin, M., Karakas, E., and Ozkose E. (2006). Prediction of relative feed value of alfalfa hays harvested at different maturity stages using *in vitro* gas production. *Livestock Research for Rural Development. Volume **18**, Article #27. http://www.lrrd.org/lrrd18/2/canb18027.htm*

Al-Ghumaiz N., (2012). Performance of some cool-season forage legumes growing under desert environment. *Legume Research*, **35** (3): 243 - 247.

Hill, J. R., Shenk, J. S. and Barnes, R. F. (1988). Breeding for yield and quality. In Hanson, A. A., Barnes, D. K. and Hill, R. R. (eds). Alfalfa and Alfalfa Improvement. Agronomy Monograph 29, ASA, Madison, USA, pp. 809-825.

Julier, B., and *Huyghe*, C. (1997). Effect of growth and cultivar on alfalfa digestibility in a multi-site trial. *Agronomie* **17**:481-489.

Kallenbach, R. L., Nelson, C. J., and Coutts, J.H. (2002). Yield, quality, and persistence of grazing and hay-type alfalfa under three harvest frequencies. *Argon. J.* **94**:1094-1103.

Karayilanli, E. and Ayhan, V., (2016). Investigation of feed value of alfalfa (*Medicago sativa* L.) harvested at different maturity stages. *Legume Research*, **39** (2): 237-247.

Kavut, Y.T. and Avcýoðlu, R. (2015). Yield and quality performances of various alfalfa cultivars in different soil textures in a Mediterranean environment. *Turkish Journal of Field Crops*, **20**:1: 65-71.

Kiraz, A.B. (2011). Determination of relative feed value of some legume hays harvested at flowering stage, *Asian Journal of Animal Veterinary Advances* **6:** 525-530.

Marquez-Ortiz, J.J., Lamb, J.F.S., Johnson, L.D., Barnes, D.K., and Stucker, R.E., (1999). Heritability of crown traits in alfalfa. *Crop Sci*. **39**:38-43.

NAFA (*National Alfalfa & Forage Alliance*) (2014). Winter Survival, Fall Dormancy & Pest Resistance Ratings for Alfalfa Varieties, *2014 Edition*, 8p. http://www.alfalfa.org/

Putnam, D.H., S.B. Orloff, and L.R. Teuber. (2005). Strageties for balancing quality and yield in alfalfa using cutting schedules and varieties. In Proc. 35th California alfalfa and forage symposium. 12-14 December, Visalia, California. :237-252.

Putnam, D.H., Robinson ,P., De-Peters, E. (2008). Forage Quality Testing. Irrigated Alfalfa Management for Mediterranean and Desert Zones. University of California Division of Agriculture and Natural Resources Pub.8302, Chapter 16:1-25.

Rotili, P.,Gnocchi, G., Scotti, C. and Zannone, L. (1999). Some aspects of breeding methodology in alfalfa. In:Proc. of The Alfalfa Genome Conf., Wisconsin.

Schroeder, J. W., (1994). Interpreting forage analysis. Extension dairy specialist, North Dakota State University, Coop. Ext. Serv. Pub. AS-1080.

Spandel, E., and Hesterman, O. B. (1997). Forage quality and alfalfa characteristics in binary mixtures of alfalfa and brome grass or timothy. *Crop Sci*. **37:**1581-1585.

Strbanovich, R., Simic, A., Postic, D., Zivanovic, T., Vuckovic, S., Pfaf-Dolovac , E., and Stanisavljevic, R. (2015). Yield and morphological traits in alfalfa varieties of different origin. *Legume Research*, **38** (4):434-441.

TUIK, (2016). Turkish Statistical Institute. Agricultural Production Statistics Database. URL: http://www.tuik.gov.tr.