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A RESEARCH ON THE HAY YIELD AND QUALITY OF ALFALFA CULTIVARS WITH DIFFERENT FALL DORMANCY RATES UNDER MEDITERRANEAN CLIMATE CONDITIONS

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ABSTRACT

This research was carried out to determine the forage yield and some quality characteristics of alfalfa cultivars with different dormancy rates under Mediterranean conditions during the years of 2019 to 2021. The experiment was established according to a randomized block design with 3 replications, in the research area of Field Crops Department of Agricultural Faculty, Cukurova University, Adana, Türkiye. In the study, alfalfa cultivars Alsancak (FD: 8), Magna 601 (FD: 5-7), Nimet (FD: 8-9), Ozpinar (FD: 8) and Sunter (FD: 5-7) have been tested. Significant differences among cultivars in terms of plant height, green forage yield, hay yield, ADF, NDF, crude protein ratio, digestible dry matter ratio and relative feed value were determined. It was concluded that the Nimet and Ozpinar cultivars with higher hay yield and quality can be more profitably grown as compared to other tested cultivars under Mediterranean climate conditions and can be recommended to the regional farmers.

Keywords: Alfalfa, cultivars, fall dormancy ratio, forage yield, quality

INTRODUCTION

Alfalfa (*Medicago sativa* L.) is grown in many parts of the world due to its high yield potential, high nutritional value and wide adaptability. Alfalfa, which is also called the queen of forage crops (Tongel and Ayan, 2010; McDonald et al., 2021), is the most important forage crop in our country with a cultivation area of 673 047 ha and a green forage production of 19 310 959 tons (TUIK, 2021).

Fall dormancy has been defined as the slowing of plant growth in fall due to a decrease in day length and temperature (Teuber et al., 1998). Alfalfa was grouped into 11 classes according to dormancy rates as very dormant (FD 1, 2), dormant (FD 3, 4) moderately dormant (FD 5), semi-dormant (FD 6, 7), non-dormant (FD 8, 9), very non-dormant (FD 10, 11) (NAFA, 2021). Fall dormancy has important effects on the adaptation of alfalfa cultivars according to the regions, on the duration of establishment, and the forage yield and quality. Indeed, Djaman et al. (2021), in their study of alfalfa cultivars with different dormancy rates found that as the dormancy rate of the cultivars increased, the hay yield decreased. Avci et al. (2018) stated that there were yield differences in alfalfa cultivars with similar dormancy rates and that the highest dry matter yield was found in cultivars with 7-9 dormancy rates, while dormant cultivars produced higher hay quality than non-dormant cultivars. Xu et al. (2012) reported that the dry matter yield averages of the cultivars ranged from 53.42 t ha^{-1} to 64.37 t ha^{-1} in a 3-year study with 19 alfalfa cultivars with different dormancy rates in 5 temperate zones of China. Rimi et al. (2010) conducted a 3-year study with 13 alfalfa cultivars with different dormancy rates under subtropical climatic conditions and reported that dry matter yields of cultivars with 7.5, 8.5 and 10.5 dormancy rates ranged between 15.9 t ha^{-1} - 18.1 t ha^{-1}, 17.3 t ha^{-1}-18.7 t ha^{-1}, 16.5 t ha^{-1} - 17.4 t ha^{-1}, respectively, and higher dry matter yields were found in cultivars with 8.5 dormancy rate. Rimi et al. (2012) reported that the hay quality decreased as the harvest time progressed, as well as the averages of NDF and ADF of cultivars increased as the dormancy rate increased, and the average crude protein ratio decreased.

Since dormant cultivars reduce shoot growth in the fall and non-dormant cultivars continue to grow in the fall, herborizing of non-dormant cultivars in coastal areas will increase hay yield. However, it is critical to consider how winter damage affects non-dormant cultivars. In this context, the purpose of the study was to determine the hay yield and quality characteristics of some semi-dormant and non-dormant alfalfa cultivars under Mediterranean climate conditions.

MATERIALS AND METHODS

The research was carried out at the research and application field of Field Crops Department of Agricultural Faculty, Cukurova University (37° 01" 01' N, 35° 21" 24' E), Adana, Turkey, during 2019-2021 years. The trial location is in the Mediterranean climate zone and is about 32 m above sea level. The average temperature during the trial years (20.3, 20.5 and 20.5 °C, respectively) in Adana was above the long-term average (19.2 °C). In 2019, when the experiment was established, the annual precipitation (1023.8 mm) was higher than the long-term average (670.4 mm) and the other 2 trial years (527.9 and 555.1 mm, respectively). The average relative humidity in 2021 (63.8%) was lower than both in the other experimental years (66.8 and 67.2 %) and long-term average (65.9%).

Soil samples were taken from 0-30 cm and 30-60 cm depths from the area where the research was carried out, and according to the results of the analysis of the soil samples; It has been determined that the pH varies between 7.05 and 7.30, the soil texture is in the sandy-clay class, the organic matter content of the soil (1.65% and 1.30%) is low, and the total nitrogen content (21.8 kg ha^{-1} and 39.0 kg ha^{-1}) is very low (Kizilkaya, 2020).

In the study, Alsancak (Dormancy rate: 8), Magna 601 (Dormancy rate: 5-7), Nimet (Dormancy rate: 8-9), Ozpinar (Dormancy rate: 8) and Sunter (Dormancy rate: 5-7) alfalfa cultivars were tested.

The experiment was established in a randomized complete block design with three replications. The plot size was determined as 5 m x 1.2 m = 6 m^2 (6 rows per plot). In the study, 20 kg ha^{-1} seed for each cultivar was sown by hand to depth of 1-2 cm. Sowing was done on 06.02.2019. Urea fertilizer based on 50 kg ha^{-1} nitrogen and triple superphosphate fertilizer based on 150 kg ha^{-1} P_2O_5 were applied to the trial area along with the sowing. Weed control was done by hand in the experimental area. Alfalfa weevil (*Hypera postica*) was seen in the first yield year of the study, and it was struggled with an insecticide with the active ingredient “Malathion” (Chessmore, 1979; Kavut et al., 2014). In the study, irrigation was done after each harvest and during the summer period as needed.

Cutting was performed when the majority of plants in the plots reached to the early flowering stage. The plots were harvested 4, 6 and 6 times during the growing season of 2019, 2020 and 2021, respectively. Before harvest, the distance between the soil surface and the last bud was measured as plant height in 10 randomly selected plants in each plot. One edge row from each side of plot were cut out and then rest of the plot was harvested and weighed to determine fresh forage yield. In order to determine hay yield, random sample 500 g fresh forage was collected from each plot, and dried at 70 °C for 48 hours, and kept at room temperature and weighed. The hay yields per hectare were calculated by proportioning the fresh forage and dried forage values obtained from each plot. The dried samples were ground to pass through a 1 mm screen, and the ratios of ADF, NDF and crude protein ratio were determined in the milled samples by The Foss XDF NIRS analyzer using the C-0904FE-Hay and Fresh Forage calibration (Hoy et al., 2002). The digestible dry matter ratio and relative feed value were calculated by the equations given by Sheaffer et al. (1995).

The data obtained from the experiment were subjected to combined analysis of variance over three years according to the design of split plots in time as defined by Steel and Torrie (1980) using the MSTAT-C statistical package program. The mean values related to the statistically significant characteristic compared with LSD and Duncan test. In order to determine the stability conditions of the cultivars, stability analysis was applied to the average hay yield values of the cultivars using the JMP statistical package program (Albayrak and Yavuz, 2020).

RESULTS AND DISCUSSION

Plant Height

According to the results of the variance analysis**,** that the cultivar, year and cultivar x year interaction did significantly affect the plant height. The average plant heights determined in different years in the alfalfa cultivars tested are given in Table 1.

While the average plant height was 50.5 cm in the first year, it was found to be statistically significantly lower than the average alfalfa plant height (72.9 cm and 73.8 cm) in the second and third years (Table 1). It can be said that because the experiment was established in February and the alfalfa developed more subsoil organs in the establishment year, a lower plant height was obtained in the establishment year compared to the yield years.

According to the three-year average results, the average plant height of alfalfa cultivars with different dormancy rates varied between 62.2 cm and 69.4 cm and this variation was found to be statistically significant (Table 1). Indeed, Nimet cultivar had significantly higher average plant height than the other tested cultivars, while Magna-601 cultivar had significantly lower mean plant height than the other tested cultivars. The plant height values obtained from different alfalfa cultivars with various dormancy rates were found to be partially higher than the plant height values obtained by Saruhan and Kusvuran (2011) under Diyarbakir conditions (53.9-63.5 cm), lower than the values obtained by Karakoy et al. (2020) under Sivas conditions (71.1-76.4 cm), and lower than the values obtained by Avci et al. (2011) under Adana conditions (68-93 cm). It can be said that the difference between the results of this study and those from the above-mentioned studies may be because the trials were established at different times, they were in different ecological conditions, and the cultivars used were of different genetics.

Table 1. Averaged values of plant height and green forage yield of alfalfa cultivars with different dormancy rates in the experimental years

	Plant Height (cm)				Green Forage Yield (kg ha^{-1})			
Cultivars	2019	2020	2021	Means of Years	2019	2020	2021	Means of Years
Alsancak	48.4 i^{+}	74.1 bc	73.3 b-d	65.3 B*	17439 j^{+}	43889 f	55872 d	39067 C*
Magna-601	51.3 gh	71.2 e	64.1 f	62.2 C	12506 k	37755 g	50139 e	33467 D
Nimet	50.9 gh	74.9 b	82.2 a	69.4 A	25955 h	53037 de	75073 a	51355 A
Ozpinar	52.5 g	71.9 de	74.6 b	66.3 B	22278 i	50085 e	60210 c	44191 B
Sunter	49.7 hi	72.2 c-e	74.8 b	65.5 B	15913 j	40501 g	63922 b	40112 C
Mean	50.5 C^{1}	72.9 B	73.8 A		18818 C^{1}	45053 B	61043 A	

1) The means with the same capital letters in the same row for a characteristic are not statistically different from each other according to the LSD test at the P≤0.05 level

*) The means with the same capital letters in the same column for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

+) The averaged values of year-cultivar combinations with the same lowercase letters for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

According to the variance analysis results, year x cultivar interaction was found to be statistically significant (Table 1), indicating that the effect of years on plant height varied significantly across different cultivars. Indeed, Nimet, Ozpinar and Sunter cultivars showed significantly higher plant height in the third year as compared to those in the other years while Magna cultivar had significantly higher plant height in the second year as compared to those in the other years. Plant height of Alsancak cultivar in the second year was significantly higher than that in the first year but not significantly different than that in the third year.

Green Forage Yield

According to the variance analysis results, it was found that year, cultivar and year x cultivar interactions caused a significant difference in green forage yield. As the years progressed, a statistically significant increase was observed in the average green forage yield of alfalfa cultivars and the highest average green forage yield was determined in the third year with 61043 kg ha^{-1} (Table 1). In addition to the fact that alfalfa, which is a perennial plant, gives priority to the development of the subsoil organs of the plant in the establishment year, the trial was sown in February due to the late preparation of the soil for sowing as a result of the continuous rains, and as a result of all these, the number of cutting in the establishment year was less than in the yield years, which can be the reason for the low green forage yield in the establishment year. Indeed, Djaman et al. (2021) reported that alfalfa cultivars sown in the fall gave higher herbage yield in the establishment year compared to the cultivars sown in the spring, in addition, the increase in herbage yield in the yield year of the spring-sown cultivars compared to the establishment year was higher than the increase in herbage yield in the yield year of the fall-sown cultivars compared to the establishment year.

According to the three-year average values, the lowest average green forage yield was found in the Magna-601 cultivar with 33467 kg ha^{-1}, and the highest average green forage yield was found in the Nimet cultivar with 51355 kg ha^{-1} (Table 1). Dormant alfalfa cultivars have been decreasing shoot growth during autumn and are not affected by extreme cold in winter by accumulating more non-structural carbohydrates at their roots. Non-dormant cultivars, on the other hand, continue to grow throughout the winter and are damaged by severe winter conditions (Castonguay and Nadeau, 1998; Dhont et al., 2002). Due to suitability of ecological conductions of the experimental area, non-dormant cultivars can continue to grow during the winter months. Therefore, it is expected that non-dormant cultivars will have a higher green forage yield compared to dormant cultivars.

The variance analysis results indicated a significant year x cultivar interaction effect on green forage yield (Table 1). This finding demonstrates that the impact of years on green forage yield significantly varied depending on the cultivars. Indeed, Nimet cultivar gave significantly higher green forage yield than Ozpinar cultivar in the first and third years while their green forage yields in the second year were not statistically significant different from each other. On the other hand, the averaged green forage yields of Alsancak and Sunter cultivar in the first year were not statistically different from each other while Alsancak cultivar gave significantly higher green forage yield than Sunter cultivar in the second year, and Sunter cultivar gave significantly higher green forage yield than Alsancak cultivar in the third year.

Hay Yield

It was found that the effect of cultivar, year and cultivar x year interaction on hay yield was significant at the level of 1%.

The average hay yields detected for alfalfa cultivars in the experimental years are shown in Table 2. As seen in Table 2, the averaged hay yield in the third year was statistically significant higher compared to other experimental years. In the experiment, the change in hay yield depending on the years is compatible with the change in green forage yield. This is also an expected result. In addition, although alfalfa weevil (*Hypera postica*) was fought in the second year of our study, complete control could not be achieved and there was a decrease in hay yield in the first cutting of the second year. For this reason, it can be said that a lower yield of hay was obtained in the second year compared to the third year. Indeed, Berberet et al. (1981) reported that the number of alfalfa weevil (*Hypera postica*) larvae increased in March-April and caused high yield losses in alfalfa.

According to the three-year average values, the average hay yield of the cultivars ranged between 9045 kg ha^{-1} and 13766 kg ha^{-1} (Table 2). Alfalfa yield varies depending on the cultivar used, harvest time, harvest frequency, climatic factors, soil structure and the effect of pests (Acikgoz, 2021). On the other hand, Malinowski et al. (2007) reported that under supplemental irrigation, non-dormant cultivars had a higher yield than dormant and moderately dormant cultivars. Cangiano et al. (2012) reported that non-dormant alfalfa cultivars produced significantly higher dry matter yield than moderately dormant and semi-dormant cultivars in humid temperate Argentina. As a matter of fact, the hay yield values obtained from tested alfalfa cultivars with different dormancy rates were partially consistent with the findings of Altinok and Karakaya (2002), Rojas-Garcia et al. (2017), Cacan et al. (2018), Atumo et al. (2021), McDonald et al. (2021), and lower than the findings of Avci et al. (2018), Oten et al. (2018), Albayrak and Yavuz (2020).

According to the variance analysis results, the year x cultivar interaction was found to be significant (Table 2), indicating that the years affected the hay yield differently in different cultivars. Indeed, the averaged hay yield of Nimet cultivar in the first year was not statistically significant different from that of Ozpinar cultivar while Nimet cultivar gave in the second and third years significantly higher hay yield than Ozpinar cultivar. On the other hand, hay yield of Alsancak cultivar in the first year was statistically significant higher than those of Magna 601 and Sunter cultivars while it was not statistically significant different from that of Sunter cultivar in the second year. In the third year, Alsancak cultivar gave significantly higher hay yield than Magna 601 cultivar but it was significantly lower than that of Sunter cultivar.

Table 2. Averaged values of hay yields and ADF ratios of alfalfa cultivars with different dormancy rates in the experimental years

	Hay Yield (kg ha^{-1})				ADF Ratio (DM%)			
Cultivars	2019	2020	2021	Means of Years	2019	2020	2021	Means of Years
Alsancak	5254 j+	12475 fg	14652 de	10794 C*	35.2 c+	34.4 d	34.6 d	34.7 B*
Magna-601	3449 k	10465 h	13220 f	9045 D	36.0 b	34.6 d	34.3 de	34.9 AB
Nimet	6598 i	15189 cd	19511 a	13766 A	35.7 b	33.9 f	34.4 d	34.6 B
Ozpinar	5936 ij	14254 e	15932 c	12040 B	35.7 b	34.0 ef	35.0 c	34.9 AB
Sunter	4165 k	11943 g	16761 b	10956 C	36.5 a	34.0 ef	35.0 c	35.2 A
Mean	5080 C[1]	12865 B	16015 A		35.8 A[1]	34.2 C	34.7 B	

1) The means with the same capital letters in the same row for a characteristic are not statistically different from each other according to the LSD test at the P≤0.05 level
*) The means with the same capital letters in the same column for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level
+) The averaged values of year-cultivar combinations with the same lowercase letters for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

ADF Ratio

The results of the variance analysis applied to the ADF ratios in the dry matter of the cultivars tested in the study showed that year, cultivar and year x cultivar caused to statistically significant differences.

The averaged rate of ADF in dry matter was found to be significantly lower in the second year of the study compared to the first and third years (Table 2). Mueller and Orloff (1994) reported that the maturation of alfalfa was delayed and the decline in herbage quality was slow during cool weathers and short days. As a matter of fact, the fact that the ADF ratio obtained in the first year of the study was higher than the other years can be explained by the fact that the plants stayed in short day conditions for a shorter period of time due to the establishment of the experiment in February and the maturation of the plants accelerated and the quality decreased.

In the research, the ADF ratios in dry matter of the cultivars varied between 34.6% and 35.2% according to the three-years average (Table 2). The lowest ADF rate was found in Nimet cultivar, and ADF ratio of Alsancak cultivar was in the similar statistical group with that of Nimet cultivar. Highest ADF ratio was determined in Sunter cultivar. Magna-601 and Ozpinar cultivars were found to be in the same statistical group with all other cultivars in this characteristic. Putnam and Orloff (2016) reported that fall dormancy had a strong effect on the forage quality of alfalfa cultivars, non-dormant cultivars showed significantly higher quality values than dormant cultivars, and ADF rate decreased by 0.6% per unit as the dormancy rate progressed from 3 to 9. In the previous researches, Avci et al. (2009) reported that the ADF ratios of alfalfa cultivars ranged from 40.7% to 41.8%. Oten and Albayrak (2018) found that the ADF ratios of alfalfa genotypes varied between 34.48% and 39.45%. The difference between the findings of this study and the researchers' findings can be explained by the fact that the cultivars used have different genetic structures and the ecological conditions in which the research was conducted were different.

The variance analysis results indicate a significant year x cultivar interaction effect on ADF ratio in dry matter (Table 2). This finding demonstrates that effect of the years on the ADF ratio varied depending on the cultivar. Indeed, Nimet, Ozpinar and Sunter cultvars showed significantly lower ADF ratios in the second year as compared in the other experimental years while ADF ratios of Alsancak and Magnum-601 in the second year were not significantly different from those in the third year.

NDF Ratio

It was found that the effects of year, cultivar and year x cultivar interaction on the NDF ratio in the dry matter of alfalfa cultivars with different dormancy rates were statistically significant (Table 3).

In the study, the average NDF ratio in dry matter of the cultivars showed a statistically significantly higher value in the first year compared to the second and third years (Table 3). It can be said that the high daylight due to the establishment of the trial in February resulted in a higher NDF ratio in the establishment year compared to productive years.

According to the three-years averaged values, the highest NDF rate was detected in Sunter cultivar, while a significantly lower NDF rate was found in Nimet cultivar compared to other cultivars (Table 3). This result revealed that dormant cultivars were of higher quality (Putnam and Orloff, 2016). The values of the NDF ratios in the dry matter of alfalfa cultivars tested in this research were found to be partially consistent with the values obtained by Eren and Keskin (2021), Avci et al. (2018) and McDonald et al. (2021).

According to the variance analysis results, the year x cultivar interaction was found to be significant (Table 3), indicating that the effect of the years on NDF ratio in dry matter varied depending on the cultivars. Indeed, Magna 601 cultivar showed statistically significant lower NDF ratio in the third year as compared to in the other experimental years while changing of the NDF ratio depending on the years in the other cultivars was significantly different from Magna 601 cultivar.

Table 3. Averaged values of NDF and crude protein ratios in dry matter of alfalfa cultivars with different dormancy ratios in the experimental years

	NDF Ratio (DM%)				Crude Protein Ratio (% DM)			
Cultivars	2019	2020	2021	Means of Years	2019	2020	2021	Means of Years
Alsancak	46.9 b-d+	46.4 d-f	45.8 f-h	46.4 B*	20.5	19.2	21.0	20.2 AB*
Magna-601	48.2 a	46.5 c-f	44.8 i	46.5 B	21.0	19.7	21.1	20.6 A
Nimet	46.0 e-g	45.2 hi	45.3 g-i	45.5 C	20.4	18.6	19.9	19.7 C
Ozpinar	47.2 bc	45.8 f-h	46.4 c-f	46.5 B	20.2	18.4	20.6	19.7 BC
Sunter	47.5 b	46.8 b-e	46.5 c-f	46.9 A	19.7	18.2	20.0	19.3 C
Mean	47.2 A[1]	46.1 B	45.8 C		20.4 A[1]	18.8 B	20.5 A	

1) The means with the same capital letters in the same row for a characteristic are not statistically different from each other according to the LSD test at the P≤0.05 level

*) The means with the same capital letters in the same column for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

+) The averaged values of year-cultivar combinations with the same lowercase letters for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

Crude Protein Ratio

According to the results of the analysis of variance, the effect of the cultivar and year factor on the crude protein ratios of the examined cultivars was found to be statistically significant, while the effect of the cultivar x year interaction was insignificant (Table 3).

In the first year of the study, the mean of crude protein ratio of the tested cultivars was 20.4%, but in the second year, it (18.4 %) was significantly lower than that in the first year. In the third year, averaged crude protein ratio was statistically indifferent compared to the first year and statistically higher as compared to the second year (Table 3).

According to the three-years average, the average crude protein ratio varied between 19.3% and 20.6% depending on the cultivars (Table 3). The highest average crude protein ratio was found in the Magna-601 cultivar with the lowest dormancy rate (20.6%), and the Alsancak cultivar with a dormancy rate of 8 was in a similar statistical group with Magna-601 in this character. In the Sunter cultivar with a dormancy ratio of 5-7, a significantly lower crude protein ratio was detected compared to the other cultivars, except for the Nimet cultivar with a dormancy ratio of 8-9 and the Ozpinar cultivar with a dormancy ratio of 8. Avci et al. (2013) found the crude protein ratios varying between 20.94% and 22.29% for 5 alfalfa cultivars under different locations and years. Turan et al. (2017) reported that the crude protein ratio averages of the cultivars varied between 16.55% and 17.55% in a two-year study with 6 different alfalfa cultivars. Avci et al. (2018) reported that the crude protein ratio of alfalfa cultivars with different dormancy rates varied between 17.6% and 19.6%.

The crude protein content of alfalfa varies depending on the cultivars used, ecological factors, day length, harvesting frequency, harvesting time, appropriate irrigation management, and the effects of disease and pests (Mueller, 1992). Indeed, the difference between the obtained crude protein values by researchers and those obtained from other studies can be explained by the genetic structures of the cultivars used and the different ecological conditions in which the studies were conducted.

Digestible Dry Matter Ratio

According to the results of variance analysis, digestible dry matter ratios of alfalfa cultivars with different dormancy rates were statistically significant influenced by cultivar and year factors as well as cultivar x year interaction. The digestible dry matter ratio values determined in different alfalfa cultivars in different years are given in Table 4.

Table 4. Averaged values of digestible dry matter ratios and relative feed values of alfalfa cultivars with different dormancy ratios in the experimental years

	Digestible Dry Matter Ratio (%)				Relative Feed Value			
Cultivars	2019	2020	2021	Means of Years	2019	2020	2021	Means of Years
Alsancak	61.5 e+	62.1 c	62.0 cd	61.8 A*	121.9 fg+	125.5 de	126.1 cd	124.5 B*
Magna-601	60.9 f	62.0 cd	62.2 bc	61.7 AB	117.6 i	124.8 de	129.3 ab	123.9 B
Nimet	61.1 f	62.5 a	62.1 c	61.9 A	123.6 ef	130.8 a	127.9 bc	127.5 A
Ozpinar	61.1 f	62.4 ab	61.7 de	61.7 AB	120.6 gh	128.4 b	123.9 d-f	124.3 B
Sunter	60.5 g	62.4 ab	61.6 e	61.5 B	118.9 hi	125.2 de	124.0 d-f	122.7 C
Mean	61.0 C1	62.3 A	61.9 B		120.5 B1	126.9 A	126.3 A	

1) The means with the same capital letters in the same row for a characteristic are not statistically different from each other according to the LSD test at the P≤0.05 level

*) The means with the same capital letters in the same column for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

+) The averaged values of year-cultivar combinations with the same lowercase letters for a characteristic are not statistically different from each other according to the Duncan test at the P≤0.05 level

As seen in Table 4, the averaged digestible dry matter ratio of the alfalfa cultivars in the first year (61.0%) of the study was statistically significant lower compared to the second (62.3%) and third years (61.9%). The changes in the digestible dry matter ratio depending on the years and cultivars were same as in the ADF ratio, which is an indicator of the cellulose and lignin content of the forage. In this context, as the ADF ratio increases, the digestion rate decreases (Yavuz et al., 2009), and it can be said that the differences in the ADF ratio among years causes the differences in the digestible dry matter ratio among years.

According to the 3-years average values, the average digestible dry matter ratios of the cultivars varied between 61.5%-61.9% and this variation was found to be statistically significant (Table 4). Canbolat et al. (2006) reported that the averaged digestible dry matter ratio of alfalfa harvested the different maturation stages was 64.65%. Avci et al. (2018) reported that the digestible dry matter ratios of the cultivars with different dormancy rates varied between 57.7% and 60.2% according to the two-year average. The difference between the findings of the researchers and the findings of our study can be explained by the fact that alfalfa cultivars were harvested at different maturity stages and the cultivars used were different.

According to the variance analysis results, the year x cultivar interaction was found to be significant (Table 4), indicating that the effect of years on digestible dry matter content varied significantly depending on the cultivars. Indeed, Nimet, Ozpinar and Sunter cultivars showed significantly higher digestible dry matter ratio values in the second year than those in the other experimental years while digestible dry matter ratios of Alsancak and Magna-601 cultivars in the second year were not statistically significant different than those in the third year.

Relative Feed Value

According to the results of analysis of variance, it was determined that the effects of cultivar, year and year x cultivar interaction on relative feed value were statistically significant at 1% level (Table 4).

In the first year of the study, the averaged relative feed value was significantly lower than the other years, while the averaged relative feed value in the second and third years was statistically indifferent (Table 4).

When the averages of three-years values were compared analyzed, cultivar Nimet had a statistically higher relative feed value than the other cultivars (Table 4). Sunter cultivar had significantly lower relative feed value than the other cultivars. Rohweder et al. (1978) developed the relative feed value to compare the quality of forage crops. They accepted the relative feed value as 100 at the full flowering stage of alfalfa and stated that the higher the relative feed value, the higher the quality of alfalfa. Van Soest et al. (1991) reported that relative feed value cannot directly measure the nutrient content of the forage, but it can be used to determine the quality in the marketing of the forage. In this context, Ball et al. (2001) determined quality standards for forage crops and categorized them as top quality, high quality, good, medium, bad, very bad according to the relative feed value higher than 151, 151-125, 124-103, 102-87, 86-75 and lower than 75, respectively. According to these values, hay produced by Nimet cultivar was in the "high quality" class, while that produced by the other cultivars was in the "good" class.

According to the variance analysis results, the year x cultivar interaction was found to be significant (Table 4), indicating that the effect of the years on relative feed value varied significantly depending on the cultivars. Indeed, relative feed values of Nimet and Ozpinar cultivars in the second year were statistically significant higher than those in the other experimental years while Magna-601 cultivar showed significantly higher relative feed value in the third year than those in the other years. Relative feed values of Alsancak and Sunter Cultivars in the second year were significantly higher than those in the first year but not significantly different from those in the third year.

Stability Status of Alfalfa Cultivars

The stability conditions of alfalfa cultivars with different dormancy rates according to hay yield and regression coefficients are shown in Figure 1.

As seen in Figure 1, Nimet and Ozpinar cultivars have higher hay yield than the general average. Sunter, Alsancak and Magna-601cultivars have lost their stability properties since they remained below the average in terms of hay yield.

The regression coefficient (b) being close to 1 indicates the cultivars' response to the environment and their stability over the years (Albayrak and Sevimay, 2005). The regression coefficient of the Ozpinar and Nimet cultivars are seen to be closer to 1 (Figure 1). In this context, it has been determined that the Ozpinar and Nimet cultivars are more stable than the other cultivars in hay yield.

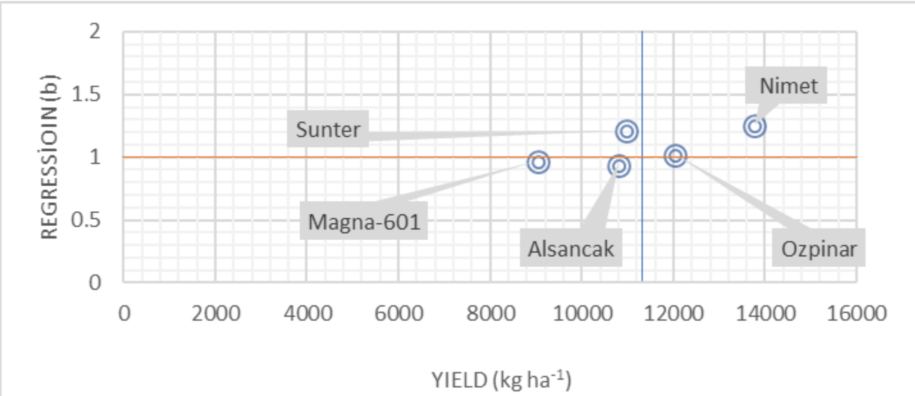

Figure 1. Stability of alfalfa cultivars with different dormancy rates according to hay yield and regression coefficients

CONCLUSION

As a result of the research carried out for three years, it was determined that the non-dormant Nimet cultivar was superior to the other tested cultivars in terms of forage yield and had moderate forage quality. The stability analysis results showed that the Ozpinar and Nimet cultivars were more stable cultivars than the other cultivars in terms of hay yield. According to these findings, it was determined that the non-dormant Nimet and Ozpinar cultivars can be grown successfully in Cukurova region. Additionally, it's important to develop alternate control methods for the alfalfa weevil (*Hypera postica*) in order to prevent forage yield and quality losses.

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