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Nutriotional Contents and Yield Performances of Lucerne (*Medicago sativa* L.) Cultivars in Southern Black Sea Shores

Mustafa Ozgur Tongel and Ilknur Ayan
Department of Agronomy, Faculty of Agriculture,
University of Ondokuz Mayis, 55139, Kurupelit, Samsun, Turkey

Abstract: Lucerne is an invaluable forage crop for Turkish farmers as it produces high quality feed during summer on lowland fields. But cultivar selection is always vague in particular regions concerning quality criteria such as protein and mineral contents which are extremely important to prevent certain diseases caused by essential element shortage. So, this study was conducted in experimental field of Black Sea Agricultural Research Institute in order to determine suitable Lucerne (*Medicago sativa* L.) cultivars for coastal conditions of Black Sea Region between 2002 and 2004. Plant height, main stem diameter, branch number of main stem, green forage yield, hay yield, crude protein contents and yield, crude ash content and yield, mineral matter were investigated in the research. The cultivar Planet, among the 19 cultivars, had the highest dry matter yield with 14.6 ton ha^{-1}; however, the cultivar Granada statistically had the lowest dry matter yield (7.7 ton ha^{-1}) in 2003. Same cultivar, Granada, did not change its place in 2004. It yielded in 18.7 ton ha^{-1} in both years. The cultivar eagle had the highest yield concerning total dry matter yield in 2003 and 2004. As a result; Granada and Bilensoy-80 cultivars were not suitable in Samsun coastal conditions and Eagle, Prista, Derby, Planet, Zajecharska-83, Calyon, MA 414, Gea, MA 324, Miral 5683, Kalender, Calfa, Artal 5588 cultivars showed better performance than the other cultivars.

Key words: Alfalfa cultivars, hay yield, crude protein content, ash content, mineral elements, cultivers

INTRODUCTION

Lucerne (*Medicago sativa* L.), also known queen of forage crops in Turkey is a promising forage crop for Turkish farmers as it produces high quality feed during summer on lowland fields.

A perennial, tap-rooted plant that produces erect stems from crown. Lucerne, also called alfalfa is mainly used as a specialist forage crop but is sometimes combined with grasses in dry, extensively grazed areas. However, it is not grazed in Turkey as it causes bloat in dairy farms. It is cut, air-dried and baled for winter consumptions.

The deep tap root of Lucerne takes up whatever water is available in dry summers. Lucerne can produce over 20 ton DM ha^{-1} on well drained, high fertile soils that have a pH >5.8 (White and Hodgson, 2005). Lucerne hay is rich in vitamins and at least contents 10 vitamins, especially carotene (Pro-vitamin A), tocopherol (Vitamin E), Vitamin K and xantophyll which is a good pigmentation agent for egg yolks and broiler skins (Acikgoz, 2001). Today, lucerne is grown in all regions of Turkey yet; the adaptation of lucerne cultivars varies from a region to another region. Perhaps, the first condition of wide-spreading lucerne agriculture and increasing yield is to determine appropriate cultivars for the regions. Gulcan and Anlarsal (1992) stated that gene center of lucerne is West Asia (Anatolia).

Lucerne cultivars, cultivated in different regions had been bred for different ecological conditions. For example, some cultivars are extremely resistant to low temperature, contrarily; some are adapted to hot climatic conditions. Anatolia which is the Asian part of Turkey has different sorts of climatic conditions.

Therefore, performances of lucerne cultivars extremely differ concerning dry matter yields and mineral contents. Quality of lucerne hay is closely related to protein and mineral contents which could be significant data to compare cultivars.

Overall, this study was established to find out whether lucerne has an important role supplying quality feed in Southern Black Sea shore conditions. Seasonal and annual patterns of 19 lucerne cultivars were also aimed to be figured out in 2003 and 2004.

Corresponding Author: Mustafa Ozgur Tongel, Department of Agronomy, Faculty of Agriculture,
University of Ondokuz Mayis, 55139, Kurupelit, Samsun, Turkey

MATERIALS AND METHODS

Experimental site: Field study was conducted at Black Sea Agricultural Research Institute in Samsun, Turkey (41°21'N Lat., 36° 15'E Long., 4 m a.s.l and no slope). The experiment was carried out during two growing seasons (2002-2003 and 2003-2004) on clay-loam soils. Before the study started, soil test had already been accomplished in Regional Directorate of Rural Services and Soil Department of Agricultural Faculty of Ondokuzmayis University, Samsun. Results from the experiment site showed that organic matter, Ca and Mg content of the soil was inadequate but K, P, Fe, Zn, Cu and Mn contents were sufficient (Table 1). Regional rainfall and temperature records were taken from the closest meteorological station which belongs to Regional Directorate of Meteorology.

Average temperatures of the years 2002, 2003 and 2004 (14.9, 14.2 and 14.0 C, respectively) were almost the same with long term means (14.2 C). Total precipitation in 2002 (573.3 mm) was lower but it was higher in 2003 (779.7 mm) and 2004 (1004.6 mm) than long term means (669.6 mm) (Table 2). Names and origins of lucerne cultivars used in the study are shown in Table 3. The experimental arrangement included a randomized complete block with 4 replicates. Sowing was done on 16th November 2002. Sowing rate 20 kg ha^{-1}, the plot size was 1.8×5 m, sowing space was 20 cm. Calcium Ammonium Nitrate was applied to experimental site in the 1st year of the experiment in accordance to 50 kg pure Nitrogen per hectare. Weeds were mechanically tried to be controlled in the 1st year to increase the competitiveness of lucerne seedlings. Harvests were done at 10% flowering stage of lucerne plots and they were irrigated after each cut. Dry matter yield was found out by drying lucerne samples in oven at 70°C to constant weight (Aydin and Tosun, 1991).

Crude protein content was calculated by multiplying the Kjeldahl nitrogen concentration by 6.25 (Kacar, 1972). Ash yields of the samples were also found out by ashing the samples in oven at 550°C for four hours (Kacar, 1972). Mineral element contents (Zn, K, Ca, Mg, Fe, Cu, Mn) of the samples obtained from second cut in 2003 and 2004 were figured out using Atomic Absorption Spectrophotometer (Kacar, 1972; Korkmaz *et al*., 1993). Data were analyzed by analysis of variance (SAS, 1998) at the p = 0.05 and 0.01 levels of significance and means were compared using the Duncan's Multiple Range Test at p = 0.05.

Table 1: Soil test results for the experimental area at Black Sea Agricultural Research Institute, Samsun, Turkey

Parameters	Values
pH	7.400
P_2O_5 (kg day^{-1})	192.400
K_2O (kg day^{-1})	1313.700
Organik Madde (%)	1.620
Ca (%)	0.670
Mg (%)	0.008
Fe (ppm)	13.790
Zn (ppm)	2.630
Cu (ppm)	7.820
Mn (ppm)	15.600

Table 2: Monthly rainfall (mm) and air temperature in 2002, 2003 and 2004 with long-term rainfall means (1974-2003)

	Average temperatures of months (c)			
Months	Long term means	2002	2003	2004
January	6.9	4.5	9.3	8.1
February	6.6	8.7	4.8	7.5
March	7.8	9.8	5.0	8.5
April	11.1	10.2	8.7	11.4
May	15.3	15.8	16.2	15.0
June	20.0	20.8	20.7	20.0
July	23.1	25.6	23.7	21.7
August	23.2	23.6	24.1	22.9
September	19.8	21.5	19.5	18.9
October	15.9	17.3	17.5	15.6
November	11.9	14.1	11.5	11.1
December	8.9	6.6	9.3	7.6
Mean	14.2	14.9	14.2	14.0
Total	-	-	-	-

	Total precipitation of months (mm)			
Months	Long term means	2002	2003	2004
January	58.4	105.4	28.1	84.2
February	48.8	35.2	77.8	43.9
March	52.7	34.1	73.5	66.2
April	58.3	61.9	45.0	101.0
May	50.6	10.9	54.7	56.2
June	47.9	53.8	3.3	77.6
July	31.3	79.9	37.2	68.1
August	31.5	14.3	3.4	14.6
September	50.9	34.6	94.0	66.2
October	87.4	42.2	194.7	83.4
November	78.6	29.7	64.0	233.4
December	73.3	71.3	104.0	109.8
Mean	-	-	-	-
Total	669.6	573.3	779.7	1004.6

Table 3: Name of the lucerne cultivars and their origins used in the experiment

Name of cultivar	Origin
Miral 5683	USA
Gea	Italy
Calyon	USA
Daisy	France
Elçi	Turkey
Prista	USA
Calfa	USA
Kalender	USA
Planet	Germany
Artal 5588	ABD
Resis	France
Zajecharska-83	Yugoslavia
MA 414	USA
Granada	USA
Eagle	USA
MA 525	USA
Bilensoy 80	Turkey
Derby	Germany
MA 324	USA

RESULTS AND DISCUSSION

In 2003, 15 cultivars were statistically in the same group regarding plant heights. The only cultivar Resis had the shortest plant height (63.44 cm) as average of four harvest-measures in 2003 (Fig. 1). In the 2nd year of the study, concerning plant height, statistically significant differences were found among the cultivars. Zajecharska-83 had the longest plant samples, whereas; Daisy (67.40 cm), Resis (66.85 cm) and Granada (66.95 cm) cultivars were in the last statistical group (Fig. 1). Acikgoz (2001) stated that plant height of lucerne cultivars could vary depending on their genetic, ecological conditions and cut times. There was no statistically difference among the cultivars regarding main stem diameter in 1st year. Cultivars might not show their performance for main stem diameter in the establishment year. In the 2nd year, cultivars showed statistical differences. For example, the cultivar Granada had the thinnest main stem diameter (2.93 mm); nine cultivars were in the same group and had the highest main stem diameters in 2004 (Fig. 2).

Regarding four cuts of lucerne cultivars, dry matter yields statistically differ in 2003. Planet totally had 14,563 kg ha^{-1} and was statistically in the 1st rank while Granada was in the last rank with 7,665 kg ha^{-1} (Fig. 3). In the 1st harvest year of the lucerne cultivars were lower than 2nd harvest year performances. The findings are similar to Cevheri (1998)'s concerning dry matter yield in the 1st harvest year. However, Colombari *et al.* (1994), Altinok and Karakaya (2002) had the lowest dry matter yield of different lucerne cultivars. First year yields of lucerne could be different depending on establishment year, ecological conditions and sowing time.

In the 2nd year of the study, 2004, cultivars performed higher dry matter yields. Totally, five cuts were done in the 2nd year and statistically significant differences were found within cultivars, however most of the cultivars were in the same group (Fig. 3). This situation might be caused by advanced genetic potential of the commercial cultivars (Hall *et al.*, 2000; Altinok and Karakaya, 2002). Cultivars which have higher plant height and main stem diameter, generally gave higher dry matter yield (Fig. 1 and 2). The lowest dry matter yield was obtained from the cultivar Granada with 18687 kg ha^{-1}. Bilensoy-80 cultivar performance was not promising and yielded 22 499 kg ha^{-1} in 2004, nevertheless Bilensoy-80 in Black Sea short conditions had better performance compared to Middle Anatolia and Izmir conditions (Bilensoy, 1985; Urem and Sabanci, 1986). Researchers conducted numerous studies with different lucerne cultivars in different ecological conditions of the Turkey and world. They revealed dry matter yields as follows: Manga (1979) 14.4-17.9 ton ha^{-1}; Tosun *et al.* (1979) 5.9-10.8 ton ha^{-1}; Mitochis and Orphanos (1981) 17.7-21.5 ton ha^{-1}; Sevimay (1992) 15.3-22 ton ha^{-1}, Sengul and Tahtaciglu (1996) 9.8-18.0 ton ha^{-1}, Colombari *et al.* (1994) 13.2-16 8 ton ha^{-1}, Firincioglu (1997) 9.5-17.1 ton ha^{-1}. The variation for dry matter yield is understandable that different cultivars in different ecological conditions could result in different dry matter yields. As average of crude protein content of cultivars obtained from 4 cuts, 15 cultivars were statistically in the first group such as Resis (21.99%)

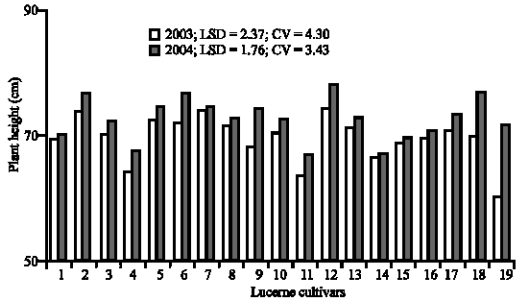

Fig. 1: Average Plant Heights of Lucerne Cultivars Grown in Samsun Coastal Regions in 2003 and 2004

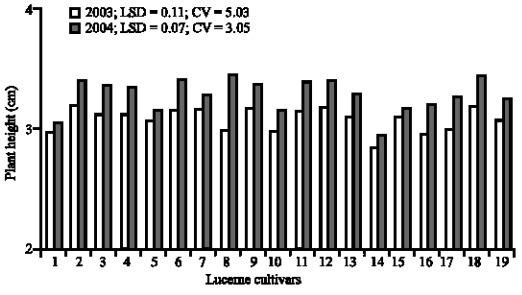

Fig. 2: Average Main Stem Diameters of Lucerne Cultivars Grown in Samsun Coastal Regions in 2003 and 2004

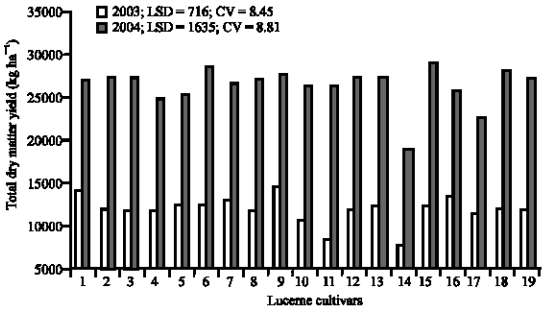

Fig. 3: Total Dry Matter Yields of Lucerne Cultivars Grown in Samsun Coastal Regions in 2003 and 2004

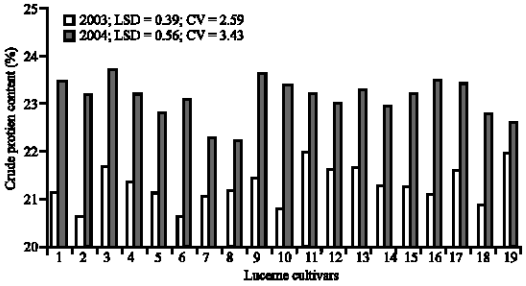

Fig. 4: Average Crude Protein Contents of Lucerne Cultivars Grown in Samsun Coastal Regions in 2003 and 2004

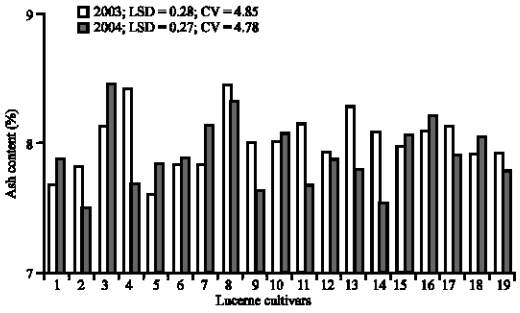

Fig. 5: Average Ash Contents of Lucerne Cultivars Grown in Samsun Coastal Regions in 2003 and 2004

and MA 324 (21.95%); 4 cultivars such as Prista (20.63%) and Gea (20.62%) were in the second group in 2003 (Fig. 4). Not surprisingly, these data were similar to 1st-year findings of lucerne which were found out by Altinok and Karakaya (2002). In the 2nd year of the study, cultivars did not show any statistically significant difference in term of crude protein content as average of 5 cuts. Crude protein contents of cultivars were between 22.22 and 23.76% in 2004. Hall *et al.* (2000) clarified that statistically significant differences were not found among the cultivars concerning quality criteria such as crude protein yield, due to similar growth pattern of commercial lucerne cultivars. On the other hand, Manga (1979) and Zorer (1997) found out the crude protein content of the lucerne cultivars between 24 and 28%, 21.17 and 28.80, respectively. The findings in the 2nd year were in harmony with these results but higher than the data which were found by Tosun (1974) 17.9%, Bilensoy (1985) 15.75-17.08%, Akbari (1992) 7.92-19.28%, Aydin *et al.* (1994) 12.6-21.0%, Acar (2002) 17.25-18.77% and Altinok and Karakaya (2002) 15-17%. Acikgoz (2001) explained that protein content of lucerne was closely related to cutting stage, drying method, climatic and environmental conditions and soil factors.

Ash content is inorganic part of the crops and gives idea about the total elements such as Ca, Mg, K, Fe, Zn etc. After ashing all samples obtained from each cut; no statistically significant difference was found among the cultivars in 2003. Ash contents of the sample changed between 8.45 (Kalender) and 7.60% (Elci). Although, almost same data was figured out in the 2nd year, statistically significant difference was found among the cultivars (Fig. 5). Ash contents of cultivars were between 7.53 (Granada) and 8.45% (Calyon).

Researchers found out the ash contents of different lucerne cultivars as following: Tosun (1974) 9.2%; Manga (1978) 12.85-15.56%; Manga (1979) 9.2-10.6%, Acar (2002) 11.37-12.02%. The findings were slightly lower than these data. Besides the cultivar differences, soil and climatic factors might affect the ash contents (Acikgoz, 2001). Lucerne samples obtained from the second cut were analyzed for mineral element contents in 2003 and 2004. Table 4 and 5 show Ca, Mg, K, Fe, Zn, Cu and Mn contents and K/(Ca+Mg) ratio. Calcium contents of the samples were in 1.08-2.33% in 2003 and 1.08-2.31% in 2004. Tajeda *et al.* (1985) and Kidambi *et al.* (1989) revealed that forages for ruminants should contain at least 0.3% Ca content. It is obviously known that lucerne forage has high calcium concentration of Ca (Table 4 and 5). These data are similar to findings of Akyildiz *et al.* (1974).

The mean of Mg content was 0.15% in 2003 and 0.13% in 2004 (Table 4 and 5). Tajeda *et al.* (1985) claimed that Mg content should be 0.1% in forages but according to Kidambi *et al.* (1989) forages should contain 0.2% Mg. On the other hand, Loreda *et al.* (1986) explained that Mg content between 0.18-0.20% would be problem for ruminants if forages had highly K concentration (1.36-1.69%). Regarding all these criteria, Mg contents in both years were lower than the data found by Akyildiz *et al.* (1974). Magnesium content of the forages must be adequate on a daily basis to avoid chronic hypomagnesemic symptoms. Many environmental factors may affect grass tetany but mineral concentrations of Mg, Ca and K in the ruminant diet are important to determining the risk of occurrence. Tetany symptoms rarely occurred when the tetany ratio of K/(Mg+Ca), in equivalent units, was <2.2 but the incidence of tetany increased rapidly when ratio values exceeded this threshold (Mayland and Grunes, 1979; Kidambi *et al.*, 1989; Ward, 1966). The ratio in the findings was 1.81 in 2003 and 2.15 in 2004 (Table 4 and 5). Potassium contents of the samples varied from 2.96-5.83% (Table 4 and 5). These data was greater than the limits (6.5 g kg^{-1}) and (0.85%) determined by NRC (1980) and Tajeda *et al.* (1985), respectively. But high potassium content could result in Mg insufficiency

Table 4: Ash, Ca, Mg, K, K/(Ca+Mg) Ratio, Fe, Zn, Cu and Mn contents of the lucerne cultivars for second cut in 2003

Cultivars	Ash content (%)	Ca (%)	Mg (%)	K (%)	K/(Ca+ Mg)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Miral 5683	7.67	1.73	0.148	2.98	1.59	374.37	40.62	7.71	19.10
Gea	7.82	1.28	0.109	3.10	2.23	370.00	43.35	14.92	13.10
Calyon	8.13	1.52	0.106	3.09	1.89	347.21	66.75	12.35	39.54
Daisy	8.41	1.29	0.079	2.97	2.18	497.56	47.25	15.69	24.73
Elçi	7.60	1.96	0.181	3.10	1.45	202.68	43.61	11.32	28.48
Prista	7.84	2.16	0.118	3.00	1.32	289.49	49.85	15.69	31.85
Calfa	7.84	1.56	0.098	3.12	1.88	422.38	64.15	7.85	23.04
Kalender	8.45	2.12	0.179	3.01	1.31	385.52	60.90	12.09	30.54
Planet	8.00	1.50	0.378	2.97	1.58	271.55	51.41	12.60	26.79
Artal 5588	8.01	2.33	0.082	3.05	1.26	307.44	58.95	11.83	28.48
Resis	8.15	1.39	0.066	2.97	2.04	365.64	50.76	10.29	27.54
Zajech.-83	7.92	1.14	0.118	3.00	2.39	290.95	33.47	6.17	21.54
MA 414	8.28	1.45	0.248	2.96	1.75	188.13	60.12	4.87	20.60
Granada	8.08	1.08	0.094	3.13	2.68	255.06	78.84	7.45	30.16
Eagle	7.97	1.45	0.193	3.01	1.83	239.54	83.00	4.42	34.10
MA 525	8.08	2.22	0.060	2.99	1.31	341.87	57.78	9.51	29.41
Bilensoy 80	8.12	1.77	0.203	2.97	1.51	361.27	41.14	9.77	26.41
Derby	7.91	1.33	0.073	3.03	2.16	612.50	36.85	8.41	37.85
MA 324	7.93	1.24	0.266	2.97	1.97	396.68	48.16	3.08	21.54
Means	8.01	1.61	0.150	3.02	1.81	343.15	53.52	9.79	27.09

Table 5: Ash, Ca, Mg, K, K/(Ca+Mg) Ratio, Fe, Zn, Cu and Mn contents of the lucerne cultivars for second cut in 2004

Cultivars	Ash content (%)	Ca (%)	Mg (%)	K (%)	K/(Ca+Mg)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Miral 5683	7.88	1.92	0.169	3.16	1.51	146.42	46.6	9.26	29.23
Gea	7.50	1.91	0.076	3.17	1.59	180.37	44.13	7.71	27.54
Calyon	8.45	2.31	0.148	3.33	1.35	202.19	51.41	10.80	31.29
Daisy	7.68	1.27	0.296	3.37	2.16	99.86	49.2	14.92	18.91
Elçi	7.83	1.48	0.251	3.51	2.03	132.35	47.51	9.00	22.10
Prista	7.88	1.16	0.206	3.25	2.38	266.70	80.01	9.51	23.41
Calfa	8.13	1.63	0.209	3.30	1.80	171.15	53.23	8.43	27.35
Kalender	8.33	1.78	0.127	3.33	1.75	599.89	42.96	9.00	27.16
Planet	7.63	1.43	0.054	3.42	2.31	181.82	39.19	6.42	22.66
Artal 5588	8.08	1.66	0.169	5.83	3.18	105.68	37.11	5.14	11.98
Resis	7.68	1.46	0.151	3.26	2.02	175.52	35.03	4.88	20.23
Zajech.-83	7.88	1.62	0.106	3.50	2.03	174.06	45.43	4.88	17.23
MA 414	7.78	1.60	0.136	3.53	2.04	158.54	36.59	4.62	25.29
Granada	7.53	1.19	0.054	3.66	2.95	194.43	42.57	7.88	18.73
Eagle	8.05	1.72	0.054	3.50	1.98	193.46	44.65	5.39	20.98
MA 525	8.20	1.55	0.079	3.72	2.28	313.26	49.46	6.68	29.60
Bilensoy 80	7.90	1.93	0.030	3.90	1.98	272.52	37.11	9.53	17.98
Derby	8.03	1.64	0.079	3.72	2.16	189.10	24.89	6.17	20.41
MA 324	7.78	1.08	0.024	3.61	3.26	219.17	36.85	5.14	26.41
Means	7.91	1.60	0.130	3.58	2.15	209.29	44.42	7.65	23.08

(Loreda *et al*., 1986). The soil factors might cause the high potassium content of lucerne samples as the experimental site had very high K content (Table 1). Fe content of the samples was 343.1 ppm in 2003 and 209.3 in 2004. It is recommended that Fe content of forages should be at least 50 ppm. Zinc content of the samples was at around threshold (53.5 ppm in 2003 and 44.1 ppm in 2004) according to Periguad (1970) and Lamand (1975). They claimed that Zn should be 50 ppm in forages, however; Danbara *et al.* (1985) and Aydin and Uzun (2002) stated that zinc contents should be 10 ppm in forages. Periguad (1970) and Lamand (1975) declared that 100 ppm Cu content should be in forages but Rybak (1977) stated that 8 ppm Cu content was sufficient for ruminants. Furthermore, Kozlowska (1977) claimed that forages should have at least 5 ppm Cu content. Concerning all these literatures, Cu contents of lucerne cultivars were at threshold and mostly sufficient (Table 4 and 5). It was suggested that forages should have 50 ppm Mn contents (Periguad, 1970; Lamand, 1975). Mn contents mean of lucerne cultivars was 27.1 ppm in 2003 while; it was 23.1 ppm in 2004. Mn contents were lower than the data recorded by Akyildiz *et al.* (1974). Bukvic *et al.* (2001) conducted a research in Serbia on lucerne cultivars. They found out Fe, Mn, Zn contents of cultivars. In the 1st year of the study, they were between 134.7 and 167.4 ppm; 53.5 and 76.0 ppm; 35.9 and 42.8 ppm, respectively. In the 2nd year, Fe, Mn and Zn contents of the cultivars were between 102.7 and 132.9 ppm, 48.4 and 65.4 ppm and 39.0. The 1st year-data in term of Fe was higher than researchers. In the 2nd year, most of the cultivars had higher Fe concentration compared to data which was found out by Bukvic *et al.* (2001). Mn and Zn contents in the 2nd year were lower than 1st year data (Table 4 and 5).

Anke *et al.* (1996) revealed that examined mineral elements (Fe, Mn, Zn, Cu, I, Mo and Ni) decreased in parallel to increasing plant age. Researchers also recommended that decreasing P, Zn, Mn, Cu and I contents could be compensate by adding mineral salts. Regarding average of mineral contents in our research, in fact, there was a decline of Fe, Zn, Cu and Mn concentrations in the 2nd year (Table 4 and 5).

CONCLUSION

Planet, Calfa, Miral 5683 and MA 525 cultivars were in the same statistical group regarding dry matter yields in 2003. Granada had the lowest dry matter yield in the same year. Eagle was the pioneer cultivar in the 2nd year but Granada repeatedly gave the lowest dry matter yield in 2004, however; most of the cultivars located in the same statistical group due to similar growth pattern of commercial lucerne cultivars. The crude protein rates of the lucerne varieties which were grown in 2003 ranged from 20.62 (Cultivar Gea) to 21.99% (Cultivar Resis). In 2004, considering the means of 5 cuts, there was no statistically significant difference among the Lucerne varieties and changed between 22.22% (Cultivar Kalender) and 23.76% (Cultivar Calyon). Ash rates of the cultivars were not statistically different from each others and ash rates were found between 7.6 and 8.45% in 2003. Interestingly, just like the data found in 2003, it was between 7.5 and 8.45% in 2004.

Trace element contents (Ca, Mg, K, Fe, Zn, Cu, Mn and K/(Ca+Mg) ratio) of second cut of lucerne cultivars which were grown were figured out in both 2003 and 2004. Ca contents of the lucern cultivars belonging to second cut in 2003 were between 1.08 and 2.33% and similarly 1.08 and 2.31% in 2004. Mg contents of the lucern cultivars in both years did not change at all (0.15% in 2003 and 0.13 in 2004). K contents varied from 2.96-5.83% in 2003 and 2004, respectively. Related to Ca, Mg and K contents, the ratio of K/(Ca + Mg) was 1.81 in 2003. This ratio slightly increased in 2004 and was found as 2.15 in parallel to K content in 2004 (5.83%).

In 2003, other trace element contents such as Fe, Zn, Cu and Mn were 343.1, 53.5, 9.79 and 27.1 ppm, respectively. In the 2nd year, except Zn, all trace element contents decreased and found 209.3, 44.1, 7.65, 23.1 ppm, respectively. According to these results, the cultivars Eagle, Prista, Derby, Planet, Zajecharska-83, Calyon, MA 414, Gea, MA 324, Miral 5683, Kalender, Calfa, Artal 5588 performed very well in Samsun Coastal conditions considering their dry matter yield other characters. However, the cultivars Granada and Bilensoy-80 did not perform as well as other cultivars and are not suitable for the region.

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