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FORAGE YIELD AND QUALITY OF GELEMEN CLOVER (*Trifolium meneghinianum* Clem.) LINES

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ABSTRACT

The aim of this research was to determine the forage yields and qualities of Gelemen clover (*Trifolium meneghinianum* Clem.) lines. The experiment design was randomized block design with three replications. In the research, significant differences were determined among dry matter yields (675-1157kg/da), crude protein contents (15.69-18.56%), crude protein yields (112.16-206.97 kg/da), contents of acid detergent fiber (30.48-34.32%), neutral detergent fiber (38.36-43.33%), total digestible nutrient (57.05-62.00%), phosphorus (0.38-0.43%), potassium (1.91-2.61%), calcium (1.39-1.61%) and magnesium (0.33-0.39%) as well as relative feed values (134-158%). According to results it was decided that 1, 3, 4 and 6 numbered Gelemen clover lines were selected to test in region yield experiments.

Key words: Trifolium meneghinianum, gelemen clover, dry matter yield, crude protein

INTRODUCTION

Trifolium nigrescens Viv is an annual, non-stoloniferous clover, native to Turkey, Iraq, Iran, Armenia, Cyprus, the Caucasus region, and the Mediterranean countries of Europe and North Africa (Zohary and Heller 1984; Gillet 1985). *T. nigrescens* is divided taxonomically into two sub-species on the basis of ovary shape and numbers of ovules per ovary. *T. nigrescens* subsp. *nigrescens* has ovaries with (3)-4-5(-6) ovules with shallow constrictions between the seeds, while subsp. *petrisavii* (Clem.) Holmboe has two ovules per ovary and a deep constriction between the seeds. T. *nigrescens subsp. petrisavii* has been further divided into two varieties on the basis of plant size and morphology, *var. petrisavii* having short, slender stems and small leaves and var. *meneghinianum* (Clem.) having long, thick, hollow stems and large leaves (Williams et al. 2001).

In present study, Gelemen clover (*Trifolium meneghinianum* Clem.) seeds were collected from Black Sea Coastal Region in 2002. Then, 12 lines were obtained using half sib family selection breeding method. Yield experiment was established in 2009. The aim of the present research was to determine forage yield and quality of Gelemen clover lines.

MATERIALS AND METHODS

Gelemen clover (*Trifolium meneghinianum* Clem.) seeds were collected from Black Sea Coastal Region in 2002. Same year, collected seeds were sown and the plants were observed in terms of growing status. In 2003, the plants were selected according to flowering time, status of erect or sloping and leaf size and width. In 2004, quintet groups were constituted for using half sib family selection breeding method. Total 12 groups were constituted. They were closed by cloth in flowering stage due to the cross pollination. This proceeding was applied in four years. After the Gelemen clover seeds were increased, yield experiment was established in 2009. Total 12 lines and 2 standard populations were used as experimental material.

Field studies were conducted at Black Sea Agricultural Research Institute (15 km east of Samsun, Turkey) in an area of the Çarşamba plain (elevation 4 m). The experiments were carried out during two growing seasons (2009-2010 and 2010-2011) on clay-loam soil. Soil pH was 6.9; organic matter 1.98 g kg^{-1}; available P, 21 g kg^{-1}; available K, 94 g kg^{-1}. The total rainfall and mean temperature for November through June was 755 mm and 13.0 °C in 2009-2010 and 785 mm and 11.6 °C in 2010-2011. The 30-yr average values of precipitation and temperature for the same period was 562 mm and 11.8°C.

Plots were established on November in 2009 and 2010. Each plot consisted of 6 rows, each 4 m in length. The row spacing was 20 cm. The seeding rate was 1 kg/da. The plots were harvested on 28 May and 26 June of 2010 and on 21 May and 19 June of 2011 at 50% flowering stage. Harvest area was 2.4 m² each plots. Samples were collected following the harvest, dried at 70°C for 48 h and weighed. The dried samples were reassembled and ground to pass through a 1-mm screen. The crude protein content was calculated by multiplying the Kjeldahl nitrogen

Figure 1. Breeding plots of gelemen clover

concentration by 6.25 (Kacar and İnal 2008). The ADF (acid detergent fiber) and NDF (neutral detergent fiber) concentrations were measured according to Ankom Technology. The total digestible nutrient (TDN) content and the relative feed value (RFV) were estimated according to the following equations adapted from Albayrak et al. (2011):

$$\text{TDN content} = (-1.291 \times \text{ADF}) + 101.35$$

$$\text{RFV} = (120)/\text{NDF}) \times ((88.9 - (0.779 \times \text{ADF})) \times (0.775)).$$

The experiment was conducted in a randomized complete block design, with 3 replications. The statistical analysis of the yield and quality data was performed using the General Linear Model procedure of SAS (SAS Inst. 1998). The means were compared using the DUNCAN test at the 0.05 probability level (Steel et al., 1997).

RESULTS AND DISCUSSION

Dry matter yield, crude protein content and yield

Year, lines and year x lines interactions on dry matter yield (DMY) content were significant (Table 1). In the first year, the highest DMY were obtained from lines 4, 8, St2 and 7 (995-1136 kg/da), in the second year, lines 3, 4, 6, 9, 2, 12 and 1 had the highest DMY (1048-1188 kg/da). Average of two years, the highest DMY were determined on line 4 (1157 kg/da) and line 3 (1053 kg/da). Albayrak et al (2006) found that Gelemen clover gave 520 kg/da dry matter yield. There were a few researches about Gelemen clover DMY. In Gelemen clover, the dry matter yield varied from 210 to 550 kg/da (Hertzch, at al. 1974). Morgner et al. (1978) obtained 400 kg/da DM yields in Gelemen clover. These Gelemen clover yields were lower than our findings.

Table 1. Dry mater yield (DMY), crude protein content (CP) and crude protein yield (CPY) of Gelemen clover lines.

	DMY (kg/da)			CP (%)			CPY (kg/da)		
Lines	**2010**	**2011**	**mean**	**2010**	**2011**	**mean**	**2010**	**2011**	**mean**
1	893 bc	1048 ac	973 bc	16.81a	18.99	17.90 ab	150.52ab	198.76be	174.64b
2	554 d	1111 ab	833 de	15.88ad	18.81	17.34 ac	87.95ef	208.82ac	148.38d
3	918 bc	1188 a	1053 ab	16.28ac	16.79	16.54 ac	149.44ab	198.19be	173.81bc
4	1136 a	1177 a	1157 a	15.04ce	20.60	17.82 ab	170.93a	243.02a	206.97a
5	571d	827 d	699 f	16.14ac	17.49	16.82 ac	92.15ef	142.23f	117.19e
6	805 c	1140 ab	973 bc	16.52ab	20.59	18.56 a	132.96bd	234.78ab	183.87b
7	995 ab	875 cd	935 bd	12.72g	18.67	15.69 c	126.50bd	164.44df	145.47d
8	1069 ab	947 bd	1008 bc	14.30ef	19.03	16.67 ac	152.54ab	181.00cf	166.77bd
9	879 bc	1137 ab	1007 bc	13.58fg	18.14	15.86 bc	119.11cd	205.69ad	162.40bd
10	916 bc	866 cd	891 ce	15.26be	18.34	16.80 ac	139.65cd	159.30ef	149.48cd
11	545 d	805 d	675 f	14.91cf	18.02	16.47 bc	81.25f	143.07f	112.16e
12	522 d	1054 ac	788 ef	14.62df	20.23	17.43 ac	75.53f	212.47ac	144.00d
St1	882 bc	883 cd	883 ce	12.65g	20.22	16.43 bc	111.52de	176..15cf	143.84d
St2	1067 ab	896 cd	981 bc	13.97eg	20.02	16.99ab	148.77ab	178.42cf	163.60bd
Mean	839 B	997 A	918	14.91 B	18.99 A	16.95	124.20 B	189.03 A	156.61
CV (%)	11.84	10.64	11.19	5.08	10.32	8.77	11.67	11.99	12.15

Means followed by the same letter in a column are not significantly different at p= 0.05 level.

Year, lines and year x lines interactions on crude protein content (CP) were significant (Table 1). The highest CP content was obtained from lines 1, 6, 3, 5 and 2 (15.88-16.81%) in the first year, while there were no statistically differences in Gelemen clover lines for CP content in the second year. Average of two years, Gelemen clover CP contents varied from between 15.69 and 18.56%. Some researchers indicated that Gelemen clover had 16.23-20.80% CP content (Hertzch, at al. 1974; Acar et al. 2001; Albayrak et al. 2006), findings that are similar to our results.

Year, lines and year x lines interactions on crude protein yield (CPY) were significant (Table 1). In the first year, the highest CPY were determined on lines 4, 8, 1, 3 and St2 (148.77-170.93 kg/da), in the second year, lines 4, 6, 12, 2, 9 and 1 had the highest CPY (205.69-243.02 kg/da). Average of two years, the highest CPY was obtained from on line 4 (206.97 kg/da).

ADF, NDF contents and TDN, RFV values

Year, lines and year x lines interactions on ADF content were significant (Table 2). The lowest ADF content was obtained from lines 1, 11, 2 and 5 (30.89-

32.25%) in the first year, while the lowest ADF content was determined on line 8, st1, st2, 2 and 6 (29.33-30.98%) in the second year. Average of two years, Gelemen clover ADF contents varied from between 30.48 and 34.32%.

Year, lines and year x lines interactions on NDF content were significant (Table 2). The lowest NDF content was exhibited lines 1, 2 and 11 (37.83-39.27%) in the first year, while the lowest NDF content was determined on line 1, 2 and 6 (37.40-38.47%) in the second. Average of two years, line 1, 2 and 11 had the lowest NDF content (35.33 between 35.88%).

ADF and NDF contents were white clover (36.9-55.4%) and red clover (41.9-58.5) (Stewart et al.2008); berseem clover (22.0-32.0) (Karslı et al.1999); crimson clover (25.8-43.7) (Ladyman et al.2003). ADF and NDF contents of Gelemen clover were similar to other clovers.

Table 2. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) contents of Gelemen clover lines

	ADF (%)			NDF (%)		
Lines	**2010**	**2011**	**mean**	**2010**	**2011**	**mean**
1	32.25 de	31.50 ac	31.88 cd	39.27 cd	38.47 de	38.87 cd
2	31.35 de	29.61 c	30.48 d	38.43 d	38.27 e	38.36 d
3	33.13 ce	34.08 a	33.60 ac	42.41 ab	42.26 ab	42.34 ab
4	35.14 ac	30.7b c	32.93 ac	43.06 ab	40.03 be	41.54 ab
5	30.89 e	34.33 a	32.61 ac	39.44 cd	41.85 ac	40.65 bc
6	35.09 ac	29.33 c	32.21 bd	43.43 ab	37.39 e	40.35 bc
7	36.81 ab	31.80 ac	34.32 a	45.02 a	41.65 ac	43.33 a
8	37.33 a	30.91 bc	34.16 a	43.38 ab	41.47 ad	42.43 ab
9	36.59 ab	31.92 ac	34.29 a	41.77 bc	40.27 ae	41.02 b
10	33.01 ce	33.40 ab	33.19 ac	39.33 cd	42.95 ab	41.14 b
11	31.85 de	32.20 ac	32.01 cd	37.83 d	38.83 ce	38.33 d
12	33.50 cd	33.10 ab	33.29 ac	40.41 bd	43.11 a	41.76 ab
St1	36.99 ab	30.82 bc	33.91 ab	45.38 a	39.05 ce	42.22 ab
St2	34.78 bc	31.44 ac	33.11 ac	43.36 ab	40.14 ae	41.75 ab
Mean	34.19 A	31.80 B	32.99	41.59 A	40.41 B	41.01
CV (%)	3.51	4.87	4.20	3.84	3.91	3.87

Means followed by the same letter in a column are not significantly different at p= 0.05 level.

Year, lines and year x lines interactions on TDN content were significant (Table 3). The highest TDN contents was obtained from lines 5, 2, 1, 11, 3 and 10 (59.53-61.57%) in the first year whereas all lines had same statistical group for TDN values except line 10, 5 and 3 in the second year. Average of two years, the highest TDN content was obtained from line 2, 1, 11 and 6 (62.00 between 59.77%). The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage. As ADF increases there is a decline in TDN which means that animals are not able to utilize the nutrients that are present in the forage (Aydın et al. 2010).

Table 3. Total digestible nutrient (TDN) and relative feed value (RFV) of Gelemen clover lines

	TDN (%)			RFV (%)		
Lines	**2010**	**2011**	**mean**	**2010**	**2011**	**mean**
1	61.02 ab	62.91 ac	60.20 ab	151 ab	156 ac	154 ac
2	61.09 ab	64.14 ab	62.00 a	156 a	160 ab	158 a
3	60.07 ac	59.72 c	57.97 bd	138 bd	137 f	138 ef
4	57.87 ce	64.46 ab	58.84 bd	133 cd	151 bd	142 df
5	61.57 a	59.97 c	59.25 bd	153 a	138 ef	146 ce
6	58.83 bd	65.45 a	59.77 ac	132 cd	164 a	148 bd
7	55.25 f	62.48 ac	57.05 d	124 d	143 df	134 f
8	55.86 ef	63.30 ac	57.26 d	128 d	145 cf	137 ef
9	55.94 ef	62.03 ac	57.08 d	134 cd	148 bf	141 df
10	59.53 ad	61.18 bc	58.51 bd	149 ab	136 f	143 df
11	60.14 ac	61.83 ac	60.03 ab	158 a	153 ad	156 ab
12	58.78 bd	62.55 ac	58.37 bd	146 ac	136 f	141 df
St1	55.08 f	64.14 ab	57.57 cd	123 d	155 ad	139 df
St2	57.47 df	63.60 ac	58.61 bd	133 cd	149 be	142 df
Mean	57.21 B	60.29 A	58.75	140 B	148 A	144
CV (%)	2.25	3.18	3.05	5.60	4.42	5.01

Means followed by the same letter in a column are not significantly different at p= 0.05 level

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Uzun (2010) stated that forages with an RFV value over 151, 150-125, 124-103, 102-87, 86-75, and less than 75 are categorized as prime, premium, good, fair, poor and rejected, respectively. Based on the average of the 2 years, the Gelemen clover lines had relative feed values ranging from 134 to 158 and, thus, may be categorized as premium (line 2, 1 and 11) and good (other lines) qualities (Table 3).

Mineral contents

P, K, Ca and Mg contents of Gelemen clover lines are given Tables 4 and 5. Year and year x lines interactions on P content were significant. Average of two years, P contents of Gelemen clover lines varied between 0.38 and 0.43%.

Year, lines and year x lines interactions on K content were significant. Mg contents of the lines varied between 2.91 and 3.60%. These results were higher than suggested values of 0.8% by Tajeda et al. (1985) and 0.65% by the NRC (1984). But high K concentration may cause Mg deficiency (Loreda et al. 1986). Acar et al. (2001) reported that gelemen clover had about 2.08% K content. These findings were similar to our results.

Table 4. Phosphorus (P) and potassium (K) content of Gelemen clover lines

	P (%)			K (%)		
Lines	**2010**	**2011**	**mean**	**2010**	**2011**	**mean**
1	0.370 a	0.473	0.421	1.57 g	2.25	1.91 d
2	0.350 bc	0.470	0.410	1.65 f	2.82	2.23 bd
3	0.370 a	0.447	0.408	2.11 c	3.11	2.61 a
4	0.340 cd	0.453	0.397	2.39 a	2.55	2.47 ac
5	0.337 de	0.457	0.397	1.69 f	2.79	2.24 bd
6	0.360 ab	0.493	0.427	2.21 b	2.85	2.53 ab
7	0.360 ab	0.503	0.432	2.22 b	2.58	2.40 ac
8	0.340 cd	0.493	0.417	2.18 bc	2.60	2.39 ac
9	0.337 de	0.460	0.398	2.37 a	2.69	2.53 ab
10	0.293 h	0.473	0.383	2.16 bc	2.48	2.32 ac
11	0.313 g	0.457	0.385	1.83 e	2.52	2.17 cd
12	0.327 ef	0.503	0.415	1.94 d	2.55	2.24 bd
St1	0.320 fg	0.500	0.410	1.91 d	2.74	2.33 ac
St2	0.310 g	0.497	0.403	1.81 e	2.49	2.15 cd
Mean	0.337 B	0.477A	0407	2.00 B	2.64 A	2.32
CV (%)	1.77	8.12	6.80	1.49	9.77	7.63

Means followed by the same letter in a column are not significantly different at p= 0.05 level.

Table 5. Calcium (Ca) and magnesium (Mg) content of Gelemen clover

	Ca (%)			Mg (%)		
Lines	**2010**	**2011**	**mean**	**2010**	**2011**	**mean**
1	1.41 bc	1.65	1.53 ad	0.387 e	0.327	0.357 ad
2	1.39 bc	1.59	1.49 bf	0.400 cd	0.266	0.333 d
3	1.43 bc	1.44	1.44 df	0.433 ab	0.263	0.348 bd
4	1.25 de	1.58	1.42 ef	0.430 ab	0.290	0.360 ad
5	1.49 b	1.57	1.53 ad	0.410 c	0.307	0.358 ad
6	1.52 b	1.60	1.56 ac	0.440 a	0.293	0.367 ad
7	1.41 bc	1.61	1.51 ae	0.433 ab	0.330	0.382 ab
8	1.42 bc	1.59	1.51 ae	0.430 ab	0.333	0.382 ab
9	1.39 bc	1.53	1.46 cf	0.437 a	0.287	0.362 ad
10	1.66 a	1.56	1.61 a	0.423 b	0.330	0.377 ac
11	1.52 b	1.64	1.58 ab	0.407 c	0.297	0.352 bd
12	1.45 bc	1.56	1.50 ae	0.410 c	0.377	0.393 a
St1	1.22 e	1.57	1.39 f	0.393 de	0.283	0.338 cd
St2	1.35 cd	1.61	1.48 bf	0.400 cd	0.330	0.365 ad
Mean	1.42 B	1.58 A	1.50	0.417 A	0.308 B	0.363
CV (%)	4.99	5.49	5.28	1.38	12.82	7.79

Means followed by the same letter in a column are not significantly different at p= 0.05 level.

Year, lines and year x lines interactions on Ca content were significant. Ca contents of the lines varied between 1.39 and 1.61%. The highest Ca content was determined on lines 10, 11, 6, 5, 1, 7, 8 and 12 (1.50-1.61%). Acar et al. (2001) reported that Gelemen clover had about 2.72% Ca content. Tajeda et al. (1985) reported that forage crops should contain at least 0.3% of Ca for ruminants. Our findings were higher than 0.3% values.

Year, lines and year x lines interactions on Mg content were significant. Mg contents of the lines varied between 0.33 and 0.39%. The least Mg content was determined on lines 11, 3 St1 and 2 (0.33-0.35%). Acar et al. (2001) reported that Gelemen clover had about 0.34% Mg content. This result was consistent with our results. Mg concentrations for forage crops were recommended as 0.2% for ruminants by Tajeda et al. (1985) and 1.0% for beef cattle by NRC (1984).

CONCLUSION

Twelve Gelemen clover lines and two standard populations were evaluated for forage yield and quality parameters in Black Sea Coastal Area. There were no improved Gelemen clover cultivars in Turkey. On the other hand Gelemen clover was commonly used by locality farmers in Middle Black Sea Coastal Region. According to present study results, Gelemen clover had higher or similar forage yield and quality parameters than other clovers (white clover, red clover, berseem clover and crimson clover etc.). End of this research, some Gelemen clover lines will be taken region yield trials. Thus, registered cultivars will be obtained at Gelemen clover.

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