Tarım Bilimleri Dergisi
Tar. Bil. Der.
Dergi web sayfası:
www.agri.ankara.edu.tr/dergi

Journal of Agricultural Sciences
Journal homepage:
www.agri.ankara.edu.tr/journal

TARIM BİLİMLERİ DERGİSİ — JOURNAL OF AGRICULTURAL SCIENCES 23 (2017) 234-241

Determination of Forage Yield and Quality Characteristics of Annual Ryegrass (*Lolium multiflorum* Lam.) Lines

Tamer YAVUZ[a], Mustafa SÜRMEN[b], Sebahattin ALBAYRAK[c], Necda ÇANKAYA[d]

[a]*Ahi Evran University, Faculty of Agriculture, Department of Field Crops, Kırsehir, TURKEY*

[b]*Adnan Menderes University, Faculty of Agriculture, Department of Field Crops, Aydın, TURKEY*

[c]*Ondokuz Mayıs University, Bafra Vocational School, Samsun, TURKEY*

[d]*Black Sea Agricultural Research Institute, Samsun, TURKEY*

ARTICLE INFO
Research Article
Corresponding Author: Tamer YAVUZ, E-mail: tameryavuz551@hotmail.com, Tel: +90 (506) 596 38 66
Received: 02 February 2015, Received in Revised Form: 18 December 2015, Accepted: 25 December 2015

ABSTRACT

In the present study, we examined forage yield and quality features of annual ryegrass (*Lolium multiflorum* Lam.) lines developed by using half-sib family selection breeding method. The study was conducted in a randomized complete block design with three replications between 2009 and 2011 years in Samsun, Turkey. Based on the average of the results of two years, significant differences were found for all parameters. In the studied lines and varieties, dry matter yields were found between 6.66 and 9.37 t ha^{-1}, crude protein contents 11.46-13.81%, crude protein yields 0.80-1.18 t ha^{-1}, acid detergent fiber 31.41-34.75%, neutral detergent fiber 48.77-52.80%, total digestible nutrient contents 56.49-60.80%, total digestible nutrient yields 376.35-556.42 t ha^{-1} and relative feed values 109.33-122.83. Annual ryegrass lines 4, 5, 6, 10 and 11 were selected for further regional yield assessments due to their superior yield and quality attributes.

Keywords: Annual ryegrass; Dry matter yield; Crude protein; Total digestible nutrient; Relative feed value

Tek Yıllık Çim (*Lolium multiflorum* Lam.) Hatlarının Verim ve Kalite Özelliklerinin Belirlenmesi

ESER BİLGİSİ
Araştırma Makalesi
Sorumlu Yazar: Tamer YAVUZ, E-posta: tameryavuz551@hotmail.com, Tel: +90 (506) 596 38 66
Geliş Tarihi: 02 Şubat 2015, Düzeltmelerin Gelişi: 18 Aralık 2015, Kabul: 25 Aralık 2015

ÖZET

Bu çalışmada yarı kardeş aile seleksiyonu ıslah yöntemiyle geliştirilen tek yıllık çim hatlarının yem verim ve kalite özelikleri araştırılmıştır. Araştırma tesadüf blokları deneme deseninde üç tekerrürlü olarak 2009-2011 yılları arasında Samsun/Türkiye'de yürütülmüştür. İki yıllık ortalama sonuçlara göre incelenen tüm parametrelerde önemli farklılıklar bulunmuştur. İncelenen hat ve çeşitlerde kuru madde verimleri 6.66-9.37 t ha^{-1}, ham protein oranları % 11.46-13.81, ham protein verimleri 0.80-1.18 t ha^{-1}, asit deterjan lif oranları % 31.41-34.75, nötral deterjan lif oranları % 48.77-52.80, toplam sindirilebilir besin oranları % 56.49-60.80, toplam sindirilebilir besin verimleri 376.35-556.42 t ha^{-1} ve nispi yem değerleri 109.33-122.83 arasında belirlenmiştir. Üstün verim ve kalite özellikleri nedeniyle 4, 5, 6, 10 ve 11 numaralı yıllık çim hatları bölge verim denmeler için seçilmişlerdir.

Anahtar Kelimeler: Tek yıllık çim; Kuru madde verimi; Ham protein; Toplam sindirilebilir besin; Nispi yem değeri

1. Introduction

Annual ryegrass (*Lolium multiflorum* Lam.) has been one of the most important forage grass species being cultivated in many parts of the world (Pivorienė & Pašakinskienė 2007; Lopes et al 2009) due to its high productivity and forage quality (Simić et al 2009). Annual ryegrasses can contain high levels of digestible nutrients for many ruminants to increase their genetic capacity for production. Rich nutritious content of annual ryegrass may be conserved for three or more months before digestibility declines (Lippke & Elis 1997). Water-soluble carbohydrate ratio is quite high in the leaves of annual ryegrass (Sandrin et al 2006) and dry matter digestibility can reach up to 80% in the early stage of development (Balasko et al 1995). In later stages of maturation of annual ryegrass, CP and digestibility decrease while ADF and NDF rates increase (Callow et al 2000; Aganga et al 2004). It is highly adaptable to different environmental and soil conditions (Evers et al 1997), and tolerant to intense and frequent grazing (Lemus 2009). Annual ryegrass can be used for grazing and sources of herbage or silage due to easy establishing and long production period with high productivity (Aganga et al 2004).

Forage production in Turkey is insufficient to meet the need of high-quality roughage, and the forage gap is compensated by using low-quality forage such as cereal straws (Koc et al 2012). To solve this problem, it is necessary to employ new varieties of forage crops, especially annual species, and to increase the production of forage. In the world, many annual ryegrass varieties have been improved for the production of high yield and quality; however, only two varieties (Efe 82 and Rambo) have been registered in Turkey.

The objectives of this study were to investigate yield and quality characteristics of annual ryegrass lines and to determine the new candidate varieties for registration.

2. Material and Methods

Annual ryegrass (*Lolium multiflorum* Lam.) seeds were collected from natural grassland vegetation in the Black Sea coastal area of Turkey. Seeds were sown in 2002 for the half sib family selection breeding process in city of Samsun in located the same coastal area. Annual ryegrass plants were observed and selected in terms of features such as flowering status, and leaf and stem characteristics for two years. At the end of this process, a total of fourteen quintet groups were created by using the half sib family selection breeding method in 2004. These groups were isolated in order to prevent cross-pollination for four years. When enough seeds were obtained, the yield trial was established with a total of 19 accessions, fourteen annual ryegrass lines and five standard cultivars (St-1; Caramba, St-2; Trinova, St-3; Teenna, St-4; Bellem and St-5; Orxy) in 2009.

Field studies were conducted during two growing seasons (2009-2010 and 2010-2011) in Samsun, Turkey (41° 13’ N, 36° 30’ E). The soil of the study area was neutral (pH 6.8), clay loam, medium in phosphorus (92 mg kg^{-1}), rich in potassium (384 mg kg^{-1}), with 1.99% organic matter content. The monthly total precipitation and average temperature for growing season (November through September) were 810 mm and 12.7 °C in 2009-2010, 870 mm and 11.4 °C in 2010-2011. Long-term average total precipitation and temperature of this period were 601 mm and 11.5 °C, respectively.

The study was carried out in a randomized complete block design with three replications. The amount of seed was 20 kg ha^{-1}. Each plot consisted of six rows, 4 m in length. The row spacing was 20 cm. The annual ryegrass lines and cultivars were sown by hand in November. The plots were harvested three times (on May 27, June 26, and September 3 in 2010, and on May 26, June 22, and September 5 in 2011) to determine dry matter yield at the 50% flowering stage. After drying for 48 hours at 70 °C, the weighed samples were passed through a 1 mm sieve and crude protein content was measured by the Kjeldahl method (AOAC 1990). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) concentrations were determined by using the standard laboratory procedures of Ankom Technology (ANKOM 2005). The total digestible nutrient (TDN) content and the relative feed value (RFV) were calculated according to the methods of Moore & Undersander (2002). The total digestible nutrient yield (TDNY) was calculated by multiplying dry matter yield (DMY) with the TDN value. All data were subjected to analysis of variance using SAS (SAS 1998) and differences between means were compared using Duncan's test at the 0.05 probability level (Steel & Torrie 1997).

3. Results and Discussion

3.1. Dry matter yield, crude protein content and yield

Annual ryegrass lines differed (P≤0.01) consistently in dry matter yield (Table 1). Dry matter yield (DMY) varied from 5.36 to 9.18 t ha^{-1} in 2010 and from 5.58 to 10.52 t ha^{-1} in 2011. The average value of dry matter yield (8.25 t ha^{-1}) in 2011 was higher than in 2010 (7.12 t ha^{-1}). This was due to the fact that the total precipitation in 2011 was higher

Table 1- Dry mater yields, crude protein contents and crude protein yields of annual ryegrass lines

Çizelge 1- Tek yıllık çim hatlarının kuru madde verimleri, ham protein oranları ve ham protein verimleri

Lines	DMY (t ha^{-1})			CP (%)			CPY (t ha^{-1})		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
1	6.40 c-f*	8.32b-e	7.36 cde	14.36	12.43	13.40 ab	0.91 a-e	1.03 b-e	0.97 bcd
2	5.93 ef	8.25 cde	7.09 de	13.88	13.42	13.65 a	0.82 cde	1.10 a-d	0.96 bcd
3	5.36 f	8.38 b-e	6.87 de	12.16	11.55	11.86 bc	0.64 e	0.96 b-f	0.80 d
4	8.24 ab	10.50 a	9.37 a	13.52	11.94	12.73 abc	1.11 ab	1.25 ab	1.18 a
5	6.74 b-f	9.60 ab	8.17 bc	12.13	13.49	12.81 abc	0.83 b-e	1.29 a	1.06 ab
6	7.99 abc	10.52 a	9.25 a	11.68	11.23	11.46 c	0.93 a-d	1.18 abc	1.05 ab
7	6.25 def	9.39 a-d	7.82 bcd	11.56	11.46	11.51 c	0.72 de	1.07 a-d	0.89 bcd
8	6.27 def	9.51 abc	7.89 bcd	12.21	10.89	11.55 c	0.76 cde	1.03 b-e	0.89 bcd
9	7.64 a-d	8.64 b-e	8.14 bc	12.13	11.59	11.86 bc	0.92 a-d	1.00 b-f	0.96 bcd
10	9.18 a	8.36 b-e	8.77 ab	12.50	11.24	11.87 bc	1.14 a	0.94 c-h	1.04 abc
11	7.95 abc	8.68 bcd	8.32 bc	12.26	13.03	12.65 abc	0.97 a-d	1.13 a-d	1.05 abc
12	6.01 ef	7.36 efg	6.69 e	13.64	11.84	12.74abc	0.81 cde	0.87 d-h	0.84 d
13	6.89 b-f	7.00 fg	6.95 de	13.62	11.30	12.46 abc	0.94 a-d	0.79 e-h	0.86 dc
14	7.86 a-d	5.58 h	6.72 e	12.02	13.23	12.63 abc	0.95 a-d	0.74 gh	0.84 d
St-1	6.94 b-f	6.38 gh	6.66 e	13.52	11.07	12.29 abc	0.93 a-d	0.70 h	0.82 d
St-2	7.67 a-d	6.98 fg	7.33 cde	12.04	11.15	11.60 c	0.91 a-e	0.77 fgh	0.84 d
St-3	8.23 ab	6.35 gh	7.29 cde	12.02	11.09	11.56 c	0.98 a-d	0.71 gh	0.85 d
St-4	7.27 bcd	8.08 de	7.67 cde	14.18	13.43	13.81 a	1.03 abc	1.08 a-d	1.05 ab
St-5	6.49 cef	8.81 bcd	7.65 cde	11.65	12.43	11.77 bc	0.75 cde	1.04 a-e	0.90 bcd
Mean	7.12 B+	8.25 A	7.68	12.69 A	11.96 B	12.33	0.90 B	0.98 A	0.94
CV (%)	11.77	8.31	9.96	10.20	9.65	9.95	15.85	13.50	14.63

*, means followed by the same letter in a column are not significantly different according to the Duncan test at the P≤0.05 level; +, overall means followed by the same capital letter are not significantly different at the P≤0.05 level

than in 2010. The increase in the total amount of precipitation had a positive effect on DMY. Based on the average of two years, DMY varied from 6.66 to 9.37 t ha^{1}, and high values were determined for line 4 (9.37 t ha^{-1}), line 6 (9.25 t ha^{-1}), and line 10 (8.77 t ha^{-1}). Higher values of DMY were obtained from line 10, 4, St-3, 6, 11, 14, St-2 and 9 than the other lines in 2010. In the second year of the study, line 6, 4, 5, 8 and 7 provided higher values of DMY than the others. Although Line 10 and 4 were in the same statistical groups in the first year of the study, these lines were categorized in different groups in the second year of the study. So, the effects of years on lines were different in both years and year x line interaction was found statistically significant ($P \leq 0.01$).

Marais & Goodenough (2000) obtained 12.6 t ha^{-1} DMY from annual ryegrass. Redfearn et al (2005) reported that DMY in annual ryegrass was 7.8-11.9 t ha^{-1}. Butler et al (2007) found that DMY of annual ryegrass was 4.55-10.51 t ha^{-1}. The dry matter yield obtained in this study was lower than values reported by Marais & Goodenough (2000). These discrepancies likely resulted from differences in ecological conditions and genotypes. Dry matter yields obtained in the current study were within the range of values reported by Redfearn et al (2005) and Butler et al (2007), although the ecological conditions and cultivars or lines examined were different. According to our results, there were significant differences between annual ryegrass cultivars and lines. Our findings were different from Redfearn et al (2002) in this regard because they argued that there were no differences between dry matter yields of annual ryegrass varieties.

There were no statistically significant differences among the crude protein contents in both years of the study, and the year x line interaction was statistically insignificant (Table 1). Crude protein (CP) content varied from 11.56 to 14.36% in 2010 and from 10.89 to 13.49% in 2011. The average CP content in the first year of the study, which was determined as 12.69%, was higher than the average CP content in the second year (11.96%) of the study ($P \leq 0.01$). A statistically significant difference ($P \leq 0.01$) was found between two-year average CP ratios of lines and standard cultivars. According to the two-year averages, higher values of CP content were obtained from lines St-4, 2, 1, 5, 12, 4, 11, 14, 13, and St-1 (12.29-13.81%) than the others. CP contents ranging from 13.4 to 17.4% have been reported by others (Meissner 1996; Johnston & Bowman 1998; Ferret et al 1999; Tran et al 2009). Sürmen et al (2013) expressed that the quality of forage might be altered due to differences in temperature and precipitation.

Effects of year, line, and year x line interactions on crude protein yield (CPY) were significant (Table 1). Crude protein yields for lines were 0.64-1.14 t ha^{-1}, 0.70-1.29 t ha^{-1} and 0.80-1.18 t ha^{-1} in 2010, 2011 and as the average, respectively. The average value of CPY (0.98 t ha^{-1}) in 2011 was higher than in 2010 (0.90 t ha^{-1}). In 2011, the increase in dry matter yield due to greater rainfall had a positive effect on crude protein yield, being related to CP content and DMY (Albayrak & Güler 2005). Based on the averaged values over two years, higher values of CPY were obtained from lines 4, 5, St-4, 6, 11, and 10 (1.04-1.18 t ha^{-1}) than the others. The lines in the same statistical groups in the first year of the study (e.g. lines 4 and 10) were categorized in different groups in the second year of the study, as the effects of years on lines were statistically different in both years indicating significant year x line interaction ($P \leq 0.01$).

3.2. Acid detergent fiber and neutral detergent fiber contents

Lower ADF values were obtained from lines 12, 4, 7, 3, 10, 1, St-5, 13, St-1 and 9 (30.62-32.72%) in the first year ($P \leq 0.05$), although there were no statistical differences among the annual ryegrass lines (30.95-36.63%) in the second year (Table 2). There was a statistically significant difference between the two-year averages of ADF ratios ($P \leq 0.05$). The average ADF value (32.61%) in 2010 was lower than the average ADF value (34.59%) in 2011 ($P \leq 0.01$). According to the two-year average, lower ADF contents were determined for line 1, St-5, 4, 3, 2, 12, 5, 10, 7, and 8 than the other lines.

Table 2- Acid detergent fiber and neutral detergent fiber contents of annual ryegrass lines

Çizelge 2- Tek yıllık çim hatlarının asit deterjan lif ve nötral deterjan lif içerikleri

Lines	ADF (%)			NDF (%)		
	2010	2011	Mean	2010	2011	Mean
1	31.87 a-e*	30.95	31.41 c	49.32 b-e	48.22	48.77 d
2	33.08 a-d	32.99	33.04 abc	49.90 bcd	53.66	51.78 ab
3	31.58 b-e	33.28	32.43 bc	49.72 bcd	54.14	51.93 ab
4	31.17 de	33.54	32.36 bc	50.22 bc	52.81	51.52 abc
5	33.75 ab	32.71	33.23 abc	51.67 ab	51.88	51.77 ab
6	33.26 a-d	35.70	34.48 ab	52.96 a	52.65	52.80 a
7	31.44 cde	35.14	33.29 abc	49.46 b-e	51.88	50.67 a-d
8	33.12 a-d	33.95	33.54 abc	49.47 b-e	51.64	50.56 a-d
9	32.72 a-e	34.94	33.83 ab	47.46 de	52.94	50.20 bcd
10	31.69 b-e	34.83	33.26 abc	46.96 e	52.07	49.52 bcd
11	34.00 a	34.56	34.28 ab	50.25 bc	52.40	51.33 abc
12	30.62 e	35.78	33.20 abc	49.24 b-e	51.65	50.45 a-d
13	32.03 a-e	35.21	33.62 ab	48.63 cde	49.80	49.22 cd
14	33.00 a-d	36.49	34.75 a	49.36 b-e	51.03	50.20 bcd
St-1	32.06 a-e	36.63	34.35 ab	48.93 cde	49.33	49.13 cd
St-2	33.37 a-d	34.72	34.04 ab	50.05 bcd	51.79	50.92 a-d
St-3	33.68 abc	35.35	34.51 ab	51.02 abc	51.50	51.26 abc
St-4	33.46 abc	35.54	34.50 ab	51.12 abc	49.01	50.07 bcd
St-5	31.87 a-e	30.95	31.41 c	49.31 b-e	48.22	48.77 d
Mean	32.61 B+	34.59 A	33.60	49.82B	51.53 A	50.67
CV (%)	3.49	5.75	4.83	2.72	3.97	3.42

*, means followed by the same letter in a column are not significantly different according to the Duncan test at the P≤0.05 level; +, overall means followed by the same capital letter are not significantly different at the P≤0.05 level

The differences among NDF values of accessions in the first year and averaged values of NDF over two years were statistically significant (P≤0.01), but effects of this factor on the NDF content in the second year was not statistically significant. (Table 2). Low NDF contents in 2010 were achieved in lines 10, 9, 13, St-1, 12, St-5, 1, 14, 7 and 8, while NDF contents in 2011 ranged from 48.22 to 54.14%. According to the averaged values over two years, lines 1, St-5, St-1, 13, 10, St-4, 9, 14, 12, 8, 7 and St-2 had low NDF content. The year x line interaction was statistically significant (P≤0.05). Line 10 placed in the group of low NDF values in 2010, although no significant differences existed between lines in 2011, this line showed a high NDF content in the second year.

It was reported that ADF contents of annual ryegrass ranged from 30.3 to 39.9% and NDF from 43.1 to 60.6% (Meissner 1996; Johnston & Bowman 1998; Ferret et al 1999; Tran et al 2009). The ADF and NDF contents of annual ryegrasses in present study were similar to results other studies.

3.3. Total digestible nutrient content, total digestible nutrient yield, and relative feed value

Effects of the lines on the TDN content in 2010 and in the combined analysis of two years were statistically significant while TDN content values of the lines in 2011 were not statistically significant different from each other (Table 3). The total digestible nutrient contents for lines were determined between 57.45 and 61.81% in 2010. In the first year of the study, lines 12, 4, 7, 3, 10, 1, 13, St-2 and 9 were in the same statistical group with higher TDN values in the first year of the study. The total digestible nutrient values in the second year varied between 54.06 and 61.40%. The average value of the first year (59.25%) was significantly higher (P≤0.01) than that of the second year (556.69%). Based on the average of two years, higher TDN contents were determined for line 1, 4, 3, 2, 12, 5, 10, 7, and 8 than the other lines. The TDN refers to the nutrients available for livestock and is related to the ADF concentration of the forage. In our study, significant differences were found among annual ryegrass cultivars and lines in digestibility. However, Redfearn et al (2002) reported that there were not any significant differences in digestibility of annual ryegrass varieties. Our results differed from findings of Redfearn et al (2002) in this aspect.

The differences among the total digestible nutrient yield (TDNY) values of the lines and cultivars were statistically significant (P≤0.01) (Table 3). The total digestible nutrient yields varied from 324.54 to 554.49 t ha^{-1} in 2010 and from 312.49 to 609.74t ha^{-1} in 2011. Average TDNY (468.49 t ha^{-1}) in the second year of the study was higher than average TDNY (421.67 t ha^{-1}) in the first year (P≤0.01). According to the averaged values over two years, TDNY varied from 376.35 to 556.42 t ha^{-1} (P≤0.01) and the higher TDNY values were obtained from lines 4, 6, and 10 than the others. The first statistical group consisted of 4,

Table 3- Total digestible nutrient content, total digestible nutrient yield, and relative feed value of annual ryegrass lines

Çizelge 3- Tek yıllık çim hatlarının toplam sindirilebilir besin oranları, toplam sindirilebilir besin verimleri ve nispi yem değerleri

Lines	*TDN (%)*			*TDNY (t ha^{-1})*			*RFV (%)*		
	2010	*2011*	*Mean*	*2010*	*2011*	*Mean*	*2010*	*2011*	*Mean*
1	60.20 a-e*	61.40	60.80 a	384.81 cde	509.49 bcd	447.15 c-h	120.67 bcd	125.00	122.83 a
2	58.65 b-e	58.75	58.70 abc	347.32 e	485.85 b-e	416.59 d-ı	118.00 c-g	109.67	113.83 bc
3	60.59 a-d	58.39	59.49 ab	324.54 e	489.36 b-e	406.95 e-ı	120.33 b-e	108.33	114.33 bc
4	61.11 ab	58.05	59.58 ab	503.10 ab	609.74 a	556.42 a	119.67 b-f	110.67	115.17 bc
5	57.77 de	59.12	58.45 abc	391.23 cde	567.50 ab	479.37 bcd	113.00 h	114.00	113.50 bc
6	58.41 b-e	55.26	56.84 bc	466.55 a-d	581.29 ab	523.92 ab	110.67 h	108.00	109.33 c
7	60.76 abc	55.99	58.37 abc	379.88 cde	525.96 a-d	452.92 c-h	121.33 a-d	110.33	115.83 b
8	58.60 b-e	57.51	58.06 abc	366.93 de	547.30 abc	457.12 c-g	118.33 c-g	112.67	115.50 bc
9	59.11 a-e	56.25	57.68 bc	451.77 bcd	486.77 b-e	469.27 b-f	124.67 ab	108.67	116.67 b
10	60.44 a-d	56.39	58.42 abc	554.49 a	471.45 c-f	512.97 abc	127.33 a	110.67	119.00 ab
11	57.45 e	56.73	57.09 bc	456.83 bcd	491.73 b-e	474.28 b-e	115.67 d-h	110.00	112.83 bc
12	61.81 a	55.17	58.49 abc	371.45 de	405.67 e-h	388.56 ghı	123.00 abc	110.00	116.50 b
13	59.99 a-e	55.89	57.94 bc	414.36 b-e	393.40 f-ı	403.88 f-ı	122.33 abc	115.00	118.67 ab
14	57.92 cde	56.22	57.07 bc	455.86 bcd	312.49 ı	384.18 hı	114.33 e-h	113.67	114.00 bc
St-1	58.74 b-e	54.25	56.49 c	406.96 b-e	345.75 hı	376.35 ı	119.00 b-g	110.33	114.67 bc
St-2	59.96 a-e	54.06	57.01 bc	459.22 bcd	377.49 ghı	418.35 d-ı	121.33 a-d	114.00	117.67 ab
St-3	58.27 b-e	56.53	57.40 bc	479.24 abc	359.93 ghı	419.59 d-ı	117.00 c-g	111.33	114.17 bc
St-4	57.87 cde	55.72	56.79 bc	419.93 b-e	450.73 d-g	435.33 d-ı	114.33 e-h	111.00	112.67 bc
St-5	58.16 cde	55.46	56.81 bc	377.26 de	489.50 b-e	433.38 d-ı	114.00 fgh	125.00	115.00 bc
Mean	59.25 A+	56.69 B	57.97	421.67 B	468.49 A	445.08	118.68 A	112.07 B	115.38
CV(%)	2.48	4.53	3.61	12.11	10.57	11.30	2.71	5.04	3.98

*, means followed by the same letter in a column are not significantly different according to the Duncan test at the P≤0.05 level; +, overall means followed by the same capital letter are not significantly different at the P≤0.05 level

6, 10 and St-3 lines in the first year, while 4, 5, 6, 7, and 8 lines occurred in the first group in the second year. The effects of years on lines were different in both years and therefore, year x line interaction was statistically significant (P≤0.01).

In 2010, the differences among the RFV values (127.33-110.67%) were statistically significant and higher values of RFV were obtained from lines 10, 9, 12, 13, 7, and St-2 than the others (Table 3). In the second year of the study, the differences among the RFV values were insignificant and they ranged from 108.00 to 125.00%. The average RFV value of the first year (118.68%) was significantly higher than that of the second year (112.07%) (P≤0.01). According to the results of the combined analysis of two years data, higher average values of RFV were obtained from lines 1, 10, 13 and St-2 compared to the others. The effects of the years on lines caused a statistically significant year x line interaction (P≤0.01). As a matter of fact, in 2010, the differences of RFV values among the lines were statistically significant. However, there was no statistical difference recorded in 2011.

RFV values of forages are classified by Kapper (2004) as prime (higher than 151%), premium (150-125%), good (124-103%), fair (102-87%), poor (86-75%), and rejected (less than 75%). Based on the average of the two years, the annual ryegrass lines had relative feed values ranging from 109.33 to 122.83 and they can be categorized as good quality (Table 3).

4. Conclusions

In this study, fourteen annual ryegrass lines were compared with five standard varieties for yield and quality characteristics. Present results indicated that some of the lines had similar or superior yield and quality characteristics than standard varieties. Therefore, lines 4, 5, 6, 10, and 11 were selected for further regional yield assessments due to their high dry matter yield, crude protein yield, digestible nutrient content, and digestible nutrient yield capacities. Some of these candidate lines may be registered as cultivars for Black Sea region in the near future.

References

Aganga A A, Omphile U J, Thema T & Wilson L Z (2004). Chemical composition of ryegrass (*Lolium multiflorum*) at different stages of growth and ryegrass silages with additives. *Journal of Biological Sciences* **4**(5): 645-649

Albayrak S & Güler M (2005). Nitrogen effects on yield and forage quality of perennial ryegrass (*Lolium perenne* L.). *Turkish Journal of Field Crops* **10**(1): 16-22

ANKOM (2005). The Ankom 200 Fiber Analyzer Procedures for ADF and NDF Analyses (Method 5 and 6). Retrieved in December, 15, 2012 from http://www.ankom.com/default.aspx

AOAC (1990). Association of Official Analytical Chemists, Official Methods of Analysis. 15th ed. Arlington, VA

Balasko J A, Evers G W & Duell R W (1995). Bluegrasses, Ryegrasses and Bentgrasses In: Barnes R F, Miller D A & Nelson C J (Eds), *Forages Vol.1: An Introduction to Grassland Agriculture*, Iowa State University Press, Ames, Iowa, USA, pp. 357-371

Butler T J, Muir J P & Provin T L (2007). Phosphorus fertilization of annual ryegrass and comparison of soil phosphorus extractants. *Journal of Plant Nutrition* **30**(1): 9-20

Callow M N, Michell P, Baker J E & Hough G M (2000). The effect of defoliation practice in Western Australia on tiller development of annual ryegrass (*Lolium rigidum*) and Italian ryegrass (*Lolium multiflorum*) and its association with forage quality. *Grass and Forage Science* **55**(3): 232-241

Evers G W, Smith G R & Hoveland C S (1997). Ecology and production of annual ryegrass. In: F M Rouquette & L R Nelson (Eds), *Ecology, Production, and Management of Lolium for Forage in the USA*, (ecologyproducti), CSSA Special Publication 24, pp. 23-29

Ferret A, Plaixats J, Caja G, Gasa J & Prio P (1999). Using markers to estimate apparent dry matter digestibility, faecal output and dry matter intake in dairy ewes fed Italian ryegrass hay or alfalfa hay. *Small Ruminant Research* **33**(2): 145-152

Johnston J & Bowman M (1998). Annual ryegrass for stored feed and pasture. Agdex 125, Ontario Ministry of Agriculture, Food, Toronto, ON

Kapper D R (2004). Appendix A: Applied Nutrition. In: Reed S M, Bayly W M & Sellon D C (Eds), *Equine*

Internal Medicine (Second Edition), Saint Louis, pp. 1543-1605

Koc A, Tan M & Erkovan H I (2012). An overview of fodder resources and animal production in Turkey. In: *Options Mediterranean, Serie A/102, New approaches for grassland research in a context of climate and socio-economic changes*, 3-6 October, Samsun, Turkey, pp. 15-22

Lemus R (2009). Utilization of annual Ryegrass. *Forage News*, Mississippi State University Extension Service, pp. 1-4

Lippke H & Ellis W C (1997). Forage quality of annual ryegrass. In: F M Rouquette & L R Nelson (Eds), *Ecology, Production, and Management of Lolium for Forage in the USA*, (ecologyproducti), CSSA Special Publication 24, pp. 71-78

Lopes V, Reis A, Barata A & Nunes E (2009). Morphological characterization of Portuguese Italian ryegrass landraces. *Journal of Central European Agriculture* **10**(1): 89-99

Marais J P & Goodenough D C W (2000). Nutritive value and dry matter yield of annual ryegrass 121c. *South African Journal of Animal Science* **30**(1): 74-75

Meissner H H (1996). A comparison of Italian ryegrass (*Lolium moltiflorum* Lam.) cultivars Exalta and Midmar with respect to their nutritive value for sheep. *South African Journal of Animal Science* **26**(2): 37-41

Moore J E & Undersander D J (2002). Relative forage quality: An alternative to relative feed value and quality index. In: *Proceedings 13th Annual Florida Ruminant Nutrition Symposium*, 10-11 January, Florida, pp. 16-29

Pivorienė O & Pašakinskienė I (2007). Genetic differences between annual and perennial ryegrass revealed by ISSR markers and their sequence characteristics. *Zemdirbyste-Agriculture* **94**: 97-204

Redfearn D, Venuto B C, Pitman W, Alison M W & Ward J D (2002). Cultivar and environment effects on annual ryegrass forage yield, yield distribution, and nutritive value. *Crop Science* **42**(6): 2049-2054

Redfearn D D, Venuto B C, Pitman W D, Blouin D C & Alison M W (2005). Multilocation annual ryegrass cultivar performance over a twelve-year period. *Crop Science* **45**(6): 2388-2393

Sandrin C Z, Domingos M & Figueiredo-Ribeiro D C L (2006). Partitioning of water soluble carbohydrates in vegetative tissues of *Lolium multiflorum* Lam. ssp. italicum cv. Lema. *Brazilian Journal of Plant Physiology* **18**(2): 299-305

SAS (1998). SAS/STAT users' guide 7.0. SAS Institute Inc, Cary, NC, USA

Simić A, Vučković S, Maletić R, Sokolović D & Djordjević N (2009). The impact of seeding rate and inter-row spacing on Italian ryegrass for seed in the first harvest year. *Turkish Journal of Agriculture and Forestry* **33**(5): 425-433

Steel R G D & Torrie J H (1997). Principles and procedures of statistics: A biometrical approach (3rd ed). McGraw-Hill Co, New York

Sürmen M, Yavuz T & Albayrak S (2013). Yield and forage quality of red clover (*Trifolium pratense* L.) varieties in Black Sea Coastal Area of Turkey. *Journal of the Institute of Science and Technology* **3**(2): 87-92

Tran H, Algado P S & Lecomte F P (2009). Species, climate and fertilizer effects on grass fibre and protein in tropical environments. *The Journal of Agricultural Science* **147**: 555-568