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Variation in Hay Yield and Quality of New Triticale Lines

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ABSTRACT

Objectives of the present study are to determine the variations in forage yield and quality of new triticale lines developed by cross-breeding methods and to develop better lines with superior characteristics over the current ones. Experiments were carried out in randomized complete block design with 3 replications during the cropping years of 2011-2012 and 2012-2013. A total of 5 cultivar and 20 lines were used as the plant material of the experiments. Genotypes were harvested at milk stage and their herbage yield, hay yield, crude protein yield and chemical composition were investigated. Two-years average results revealed that herbage yields varied between 36.44-48.47 t ha^{-1}, hay yields between 12.77-18.68 t ha^{-1}, crude protein yields between 1.02-1.80 t ha^{-1}, acid detergent fiber (ADF) between 32.92-44.63%, neutral detergent fiber (NDF) between 63.72-78.47%, crude ash ratios between 5.06-7.87%, crude protein content between 6.21-11.36%, dry matter digestibility (DDM) between 54.14-63.25%, dry matter intake (DMI) between 1.528-1.881 and relative feed value (RFV) between 64.18-89.31. Current results revealed superior characteristics for new triticale genotypes developed with cross-breeding over the current standard lines with regard to investigated parameters. It was concluded that cross-breeding yielded positive outcomes and therefore, currently investigated high-yield and quality lines should be prepared for registration.

Keywords: Triticale; New lines; Hay yield; Chemical composition; Relative feed value

Yeni Tritikale Hatlarında Ot Verim ve Kalite Özelliklerinde Varyasyon

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ÖZET

Çalışmanın amacı yeni melez tritikale hatlarının ot verimi ve ot kalitesi yönünden varyasyonu belirlemektir. Deneme 2011-2012 ve 2012-2013 yıllarında 2 yıl süre ile tesadüf blokları deneme desenine göre 3 tekrarlamalı olarak kurulmuş ve analiz edilmiştir. Araştırmada 5 çeşit ve 20 hat kullanılmıştır. Bitkiler süt olum döneminde hasat edilmiştir. Araştırmada yeşil ot verimi, kuru ot verimi, ham protein verimi, ham protein oranı, ADF, NDF ve ham kül oranı incelenmiştir. İki yıllık araştırma sonuçlarının ortalamasına göre; yeşil ot verimi 36.44-48.47 t ha^{-1}, kuru ot verimi 12.77-18.68 t ha^{-1}, protein verimi 1.02-1.80 t ha^{-1}, asitte çözünmeyen lif (ADF) oranı % 32.92-44.63, nötrde çözünmeyen lif (NDF) oranı % 63.72-78.47, ham kül oranı % 5.06-7.87, ham protein oranı % 6.21-11.36, sindirilebilir kuru madde (SKM) % 54.14-63.25, kuru madde tüketimi (KMT) 1.528-1.881 ve nispi yem değeri (NYD) 64.18-89.31 arasında değişmiştir. Araştırma sonuçlarına göre; melezleme ile elde edilen yeni tritikale genotiplerinin incelenen özellikler yönünden değerleri standart çeşitlerden daha yüksek olmuştur. Yapılan melezleme sonuçlarının olumlu neticeler verdiği ve bu hatların ot verimi ve kalitesi yönünden tescil için hazırlanması gerektiği düşünülmektedir.

Anahtar Kelimeler: Tritikale; Yeni hatlar; Kuru ot verimi; Kimyasal kompozisyon; Nispi yem değeri

1. Introduction

Cool season cereals like oat, barley, wheat, rye and triticale are usually grazed during tillering period or commonly harvested as forage source for livestock (Uncuer 2011). Triticale is the cross-breed of wheat and rye and used both for kernel and herbage yields (Iğne et al 2007). While triticale provides at least 20% more hay yield than wheat, forage quality is also better than wheat and rye (Koch & Paisley 2002; Mut et al 2006). Triticale is also a good feed source for livestock because of its high protein yield and amino acid balance.

Breeding materials are usually evaluated with regard to yield characteristics, resistance against biotic and abiotic stress conditions and forage quality parameters. Forage quality is commonly evaluated by Relative Feed Value criteria developed in the USA for alfalfa and other coarse fodder (Rohweder et al 1978; Ball et al 1996; Bozkurt 2011). Such quality varies based on crop species, harvest or grazing durations, cultural practices and climate parameters. Besides, livestock productivity depends on the amount of feed consumed by the animals, availability and digestibility of the feed (Van Soest 1982; McDonald et al 1995; Lekgari et al 2008). In present study, variations in forage yields and quality of some triticale lines developed by cross-breeding methods were investigated and better lines with superior characteristics over the current registered ones were tried to be developed. This will be the first study in Turkey investigating forage yield and quality parameters of triticale lines.

2. Material and Methods

Experiments were carried out over the research fields of Eastern Mediterranean Transition Zone Agricultural Research Center during the cropping years of 2011-12 and 2012 -13. The genotypes used in experiments are provided in Table 1.

The research province, Kahramanmaraş is located in Eastern-Mediterranean Region between 37^{o} 38’ North latitudes and 36^{o} 37’ East longitudes and has an altitude of 568 m. Mediterranean climate is dominant in the province and day-night temperature difference is low. Climate parameters for research site are provided in Table 2 (TSMS 2012; TSMS 2013).

While the long-term average precipitation of the experimental site is 669.1 mm, annual total precipitations of the experimental years 2011-12 and 2012-13 respectively realized as 756.8 and 583.1 mm. The first cropping year had 87.7 mm higher precipitation and the second year had 86 mm lower precipitation than the long-term average. Beside the amount, distribution of the precipitation within the year also significantly varied between the years. Especially, the amount of precipitation during the germination, emergence and initial growth period of the second year (November-December) were relatively lower than the long-term average. The amount of precipitations during January and February of the first year were significantly higher than that of the second year and long-term average (Table 2). On the other hand, the amount of precipitations during plant generative development periods (booting, spiking, flowering) covering the months March and April of both years were below the long-term average. Long-term annual average temperature of Kahramanmaraş Province is 12.6 ˚C. Annual average temperatures of the experimental years respectively realized as 12.5 and 14.0 ˚C. Temperature in April of the first year was higher and the temperature in May was lower than the second year and long-term average. Annual average relative humidity of the province is 62.0% and the relative humidity of the experimental years respectively realized as 57.2 and 61.9%.

The soil texture is loamy with a soil pH of 7.61 in the first year and 8.00 in the second year. Lime contents were respectively observed as 12.55% and 24.59%. Available phosphorus varied between 0.046 – 0.080 t ha^{-1}, available potassium between 0.459 – 1.270 t ha^{-1}. Organic matter contents of the soils varied between 1.22 - 0.97.

Experiments were carried out in randomized complete block design with 3 replications. Seeding rate was 500 seeds m^{-2} and seeding was performed with a plot-drill over 6 x 1.5 m size plots. There were 6 rows in each plot with row spacing of 20 cm. In both years, 0.08 t N and 0.08 t P2O5 ha^{-1} were applied to soil during sowings and additional 0.1 t ha^{-1} N was supplied during tillering period. Irrigation was not performed in both years and herbicide (Grand Star) was used for broad-leaf weeds. Plants were harvested at milk-stage. Side rows and 1 m strips at top and bottom of the plots were omitted as side effects. A total of 500 g fresh sample was taken from harvested plants and dried at 70 ºC for 48 hours. Then, dry matter ratios and hay yields were determined.

Table 1- Pedigrees for triticale lines

Çizelge 1- Tritikale hatlarına ait pedigriler

Genotypes	*Genotype pedigrees*
Line 1	Mikham-2002 / 01-02 Stbvd-21
Line 2	Cimmyt-3 / Anoas_3/Tatu_4//Susi_2
Line 3	431_Tu_1-11/3/Dargo/Ibex//Civet#2/Karma
Line 4	Samur Sortu / 01-02 Stbvd-19
	Tatlicak-97
Line 6	Cimmyt-3 / Karma
Line 7	01-02 Ktbvd-1/ Karma
Line 8	23Fahat5/Pollmer3ctss/Pollmer_3/Foca_2-1
Line 9	23Fahat5/Pollmer3ctss/Pollmer_3/Foca_2-1
	Melez-2001
Line 11	23Fahat5/Pollmer3ctss/Pollmer_3/Foca_2-1
Line 12	Bagal_3/Faras_1/3/Ardi_1/Topo1419//Erizo_9/Karma
Line 13	Fahad_8-2*2//Ptr/Pnd-T/3/Erizo_11//Yogui_3/ Pollmer_3/Foca_2-1
Line 14	Ct179.80/3/150.83//2*Tesmo_1musx603/01-02ktvd-17
	Mikham-2002
Line 16	Cimmyt-3 / Anoas_3/Tatu_4//Susi_2
Line 17	Cimmyt-3 / Karma
Line 18	23fahat5/Pollmer3ctss/Pollmer_3/Foca_2-1
Line 19	Chd1089/Pollmer_2.3.1/Pollmer_3/Foca_2-1
	Alperbey
Line 21	Ct179.80/3/150.83//2*Tesmo_1musx603/01-02ktvd-17
Line 22	Presto 6d(6a)//Bull_10/Manati_1/01-02 Ktvd-32
Line 23	Bull_10/Manati_1//Faras/Cmh84.4414
Line 24	33--1/42—2
	Karma

Table 2- Climate parameters for experimental years and long term averages

Çizelge 2- Deneme yılları ve uzun yıllar ortalamasına ait bazı iklim verileri

Months	Precipitation (mm)			Temperature (°C)			Relative humidity (%)		
	2011-2012	2012-2013	Long-term (1975-2011)	2011-2012	2012-2013	Long-term	2011-2012	2012-2013	Long-term
November	93.2	36.4	90.9	8.7	13.4	11.5	60.6	70.6	64.7
December	85.2	67.6	124.4	6.3	7.7	6.6	64.7	76.4	71.3
January	325.0	111.0	125.4	6.9	6.2	4.9	79.9	72.3	70.0
February	199.1	131.9	112.3	4.1	8.6	6.3	61.9	74.0	66.0
March	0.0	77.5	94.8	8.6	11.3	10.6	51.8	52.1	60.5
April	0.0	65.9	76.1	17.7	17.1	15.4	49.3	52.5	58.4
May	41.3	76.5	39.3	19.9	22.4	20.4	55.8	53.4	54.7
June	13.0	16.3	5.9	27.9	25.4	25.2	33.4	43.9	50.7
Total	756.8	583.1	669.1						
Average				12.5	14.0	12.6	57.2	61.9	62.0

Table 3- Physical and chemical characteristics of experimental soils

Çizelge 3- Deneme alanı topraklarının bazı fiziksel ve kimyasal özellikleri

Years	Texture	pH	$CaCO_3$ (%)	P_2O_5 ($t\ ha^{-1}$)	K_2O ($t\ ha^{-1}$)	Organic matter (%)
2011-12	Loamy	7.61	12.55	0.046	0.459	1.22
2012-13	Loamy	8.00	24.59	0.080	1.270	0.97

Hay samples were grinded in a hand-mill with 1 mm sieve. Crude ash contents of the samples were determined by burning the samples at 550 °C for 8 hours. Kjeldahl method was used to determine nitrogen (N) contents of dry samples. Crude protein ratios were calculated by using the equation of N x 6.25 (AOAC 1990). NDF (Van Soest & Wine 1967) and ADF (Van Soest 1963) contents were analyzed with an ANKOM 200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA) device. Dry matter digestibility, dry matter intake and relative feed value (RFV) were calculated by using the following equations (Rohweder et al 1978):

To calculate relative feed value, initially dry mater digestibility (DMD) was calculated from ADF value by;

$$DMD\% = 88.9 - (0.779 \times ADF\%) \qquad (1)$$

Dry matter intake (DMI) based on animal live-weight was calculated from NDF value by;

$$DMI\% \text{ of } BW = 120 / NDF\% \qquad (2)$$

Then, relative feed value was calculated from DMD and DMI by;

$$RFV = DDM\% \times DMI\% \times 1.29 \qquad (3)$$

Relative feed values were evaluated by using the values provided in standards for hays in Table 4.

Data variance analyses were performed by using SAS (SAS Inst., 1999) statistical software. Duncan's multiple range tests was employed to compare the treatment means. Cluster analysis of 25 triticale lines was performed by using DICE similarity index and UPGMA method and dendrograms were prepared for yield, chemical composition and digestibility parameters.

Table 4- Relative feed value standards[a]

Çizelge 4- Nispi yem değeri standartları[a]

Quality standards	*CP*	*ADF (%) (DM)*	*NDF (%) (DM)*	*RFV*
The best quality	>19	<31	<40	>151
1	17-19	31-40	40-46	151-125
2	14-16	36-40	47-53	124-103
3	11-13	41-42	54-60	102-87
4	8-10	43-45	61-65	86-75
5	8.00	>45	>65	<75

[a], relative feed value is assumed to be 100 when the ADF is 41% and NDF is 53% (Rohweder et al 1978)

3. Results and Discussion

Herbage, hay and protein yields of triticale genotypes are provided in Table 5. While only the differences between protein yields of the years were not significant, the differences between the entire parameters of the years, genotypes and year x genotype interactions were found to be significant (P<0.01). The lowest herbage yield of the first year was observed in line L9 (30.09 t ha^{-1}) and the highest in L19 (49.56 t ha^{-1}). During the second year, the lowest and the highest values were respectively observed in L21 (32.84 t ha^{-1}) and Melez 2001 (54.69 t ha^{-1}). With regard to average of years, the lowest herbage yield was obtained from L21 (36.44 t ha^{-1}) and the highest from L4 (48.47 t ha^{-1}). The lowest hay yields were observed in cultivar Karma with 12.44 t ha^{-1} in the first year, 13.09 t ha^{-1} in the second year and 12.77 t ha^{-1} as the average of years. The highest hay yield was obtained from L19 (21.13 t ha^{-1}) in the first year and from L8 in the second year and as the average of years (respectively with 20.36 and 18.68 t ha^{-1}). The lowest crude protein yield was observed in L1 (0.96 t ha^{-1}) in the first year, in L7 (0.99 t ha^{-1}) in the second year and in L12 (1.02 t ha^{-1}) as the average of years. The highest crude protein yield of the years and average of the years were all observed in L12 respectively as 1.77, 1.80 and 1.78 t ha^{-1}.

Chemical composition of the triticale genotypes are provided in Table 6. The differences between entire chemical composition parameters were found to be significant (P<0.01). ADF ratios varied between 30.97-46.45% in 2011 with the lowest ratio in L24 and the highest in L12. The ADF values of the year 2012 varied between 33.48–44.44% with the lowest value in the cultivar Alperbey and the highest value in L7. With regard to average of years, the lowest value was seen in L24 (32.92%) and the highest value in L12 (44.63%). The NDF ratios of the first year varied between 59.84-79.28% with the lowest value in L1 and the highest value in L12. During the second year, NDF values varied between 59.52-77.66% with the lowest ratio in cultivar Karma and the highest ratio in L12. Considering the average of years, the values varied between 63.72-78.47% with the lowest value in L2 and the highest value in L12. The lowest crude ash ratio of the first year was observed in L18 (4.85%), the lowest value of the second year in L21 (4.88%) and the lowest average of years in L21 (5.06%). The highest values of the first and second year and the average of years were respectively observed in L9 (8.89%), L3 (7.82%) and L9 (7.87%). Relatively larger differences were observed in crude protein ratios of the triticale genotypes. While L1 yielded the lowest crude protein ratio in both years and average of years, the highest value was obtained from L12 (12.48%) in the first year, from cultivar Mikam (10.69%) and as the average of years from L12 (11.36%).

Table 5- Yield values of triticale genotypes

Çizelge 5- Tiritikale genotiplerine ait verim değerleri

Genotypes	HeyY (t ha^{-1})			HY (t ha^{-1})			CPY (t ha^{-1})		
	2011	2012	Average	2011	2012	Average	2011	2012	Average
Line 1	36.67 defghi	53.52 a	45.09 cd	15.05 efgh	17.78 bcde	16.42 efghi	0.96 k	1.07 jkl	1.02 m
Line 2	30.94 kl	46.46 bcdef	38.70 jk	13.19 hij	18.30 bcd	15.75 hijk	1.14 ghij	1.36 bcdef	1.25 fghi
Line 3	36.78 defgh	46.69 bcdef	41.74 fgh	14.96 efghi	19.33 ab	17.14 bcdefg	1.07 ijk	1.23 fghi	1.15 jkl
Line 4	46.94 a	49.99 b	48.47 a	19.34 b	16.24 efgh	17.79 abcd	1.69 a	1.40 bcde	1.55 b
Tatlıcak	35.06 fghi	47.63 bcde	41.34 fghi	12.51 j	16.84 def	14.67 klm	1.13 hijk	1.30 defg	1.21 ghij
Line 6	43.38 b	40.66 ij	42.02 efg	16.98 bc	16.00 efgh	16.49 efgh	1.32 defg	1.10 ijkl	1.21 ghij
Line 7	33.94 ghijk	44.60 defgh	39.27 hij	14.84 efghi	13.94 ij	14.39 lm	1.10 hijk	0.99 l	1.05 lm
Line 8	38.81 cde	45.17 cdefg	41.99 efg	17.00 cd	20.36 a	18.68 a	1.22 efghij	1.42 bcd	1.32 def
Line 9	30.09 l	48.64 bc	39.37hij	13.80 ghij	19.47 ab	16.64cdefgh	1.04 jk	1.30 defg	1.17 hijk
Melez2001	40.23 bcd	54.69 a	47.46 ab	15.75 defg	19.00 abc	17.37 bcdef	1.24 efghi	1.29 defg	1.27 efgh
Line 11	36.17 efghi	42.08 ghij	39.12 hij	14.17 fghij	18.09 bcd	16.13 fghi	1.33 def	1.33 cdef	1.33 def
Line 12	33.19 hijkl	48.00 bcd	40.60 fghij	14.16 fghij	17.53 cdef	15.85 hijk	1.77 a	1.80 a	1.78 a
Line 13	46.72 a	44.38 defgh	45.55 bc	18.48 bc	175.84 cde	18.03 ab	1.76 a	1.27 efgh	1.51 b
Line 14	31.13 jkl	44.92 cdefg	38.03 jk	13.03 ij	16.28 efgh	14.66 klm	1.08 ijk	1.46 bc	1.27 efgh
Mikam2002	34.44 ghijk	41.66 ghij	38.05 jk	14.23 fghij	13.33 j	13.78 mn	1.64 ab	1.42 bcd	1.53 b
Line 16	39.39 cde	41.93 ghij	40.66 ghij	18.21 bc	17.05 def	17.63 abcde	1.27 defgh	1.46 bc	1.37 cde
Line 17	39.00 cd	40.92 hij	40.41 ghij	18.25 bc	15.74 fgh	17.00 bcdefg	1.52 bc	1.49 b	1.50 b
Line 18	33.06 ijkl	46.12 cdef	39.60 ghij	14.68 efghi	17.41 cdef	16.04 ghıj	1.18 fghij	1.14 hijk	1.16 ijk
Line 19	49.56 a	36.53 k	43.04 def	21.13 a	14.64 hij	17.88 abc	1.39 cde	1.19 ghij	1.29 defg
Alperbey	38.50 cdef	39.83 j	39.17 hij	15.53 defg	14.89 ghi	15.21 ijkl	1.07 ijk	1.10 ijkl	1.08 klm
Line 21	40.04 bcd	32.84 l	36.44 k	18.50 bc	13.93 j	16.21 fghi	1.75 a	1.18 ghij	1.46 bc
Line 22	37.53 cdefg	46.43 bcdef	41.98 efg	15.90 def	17.32 cdef	16.61 defgh	1.32 def	1.43 bcd	1.37 cd
Line 23	34.67 ghij	43.62 fghi	39.14 hıj	14.75 efghi	15.00 ghi	14.87 jklm	1.14 ghij	1.09 jkl	1.12 jklm
Line 24	40.78 bc	47.99 bcd	44.38 cde	16.28 de	16.51 defg	16.40 efghi	1.43 cd	1.46 bc	1.44 bc
Karma	33.61 hijkl	44.04 efghi	38.82 ijk	12.44 j	13.09 j	12.77 n	1.13 hijk	1.04 kl	1.09 klm
Genotype	**	**	**	**	**	**	**	**	**
Year	**	**	**	**	**	**	**	**	NS
Year x Genotype	**	**	**	**	**	**	**	**	**

$^{a, b, c}$, row means with common superscripts do not differ (P>0.05); NS, non-significant; Sig., significance level; *, P<0.05; ** , P<0.01; HeyY, , herbage yield; HY, hay Yield; CPY, crude protein yield

Table 6- Chemical composition of triticale genotypes

Çizelge 6- Tritikale genotiplerine ait kimyasal kompozisyon

Genotypes	ADF (%)			NDF (%)			CA (%)			CP (%)		
	2011	2012	Average	2011	2012	Average	2011	2012	Average	2011	2012	Average
Line 1	41.96 b	43.12 b	42.54 b	59.84 y	68.73 n	64.29 v	61.12 g	5.61 j	5.87 l	6.40 o	6.03 r	6.21 o
Line 2	36.49 h	34.66 q	35.58 kl	62.72 w	64.73 r	63.72 w	6.27 e	6.15 h	6.21 hi	8.67 ef	7.41 k	8.04 h
Line 3	37.76 fg	38.75 i	38.26 gh	72.28 g	72.12 i	72.20 i	6.64 c	7.82 a	7.23 b	7.15 lm	6.34 q	6.74 n
Line 4	33.83 klm	37.65 kl	35.74 jk	65.97 s	68.19 o	67.08 r	5.53 k	5.46 k	5.50 o	8.75 de	8.63 e	8.69 de
Tatlıcak	41.14 bc	42.10 e	41.62 c	72.05 h	70.16 l	71.10 j	5.85 h	7.54 b	6.70 d	8.99 de	7.74 j	8.37 fg
Line 6	38.78 ef	43.09 b	40.93 d	72.49 f	75.46 c	73.98 e	6.39 d	5.95 i	6.17 i	7.76 ijk	6.87 o	7.32 jk
Line 7	39.45 de	44.44 a	41.94 c	69.76 m	71.79 j	70.78 l	5.63 j	5.98 i	5.80 m	7.42 kl	7.10 m	7.26klm
Line 8	33.52 lm	35.80 n	34.66 mn	61.32 x	70.01 l	65.67 u	5.85 h	5.35 l	5.60 n	7.18 lm	6.99 n	7.08 m
Line 9	34.68 jk	37.72 k	36.20 j	70.61 l	75.24 d	72.92 h	8.89 a	6.86 e	7.87 a	7.54 jkl	6.66 p	7.10 lm
Melez2001	40.49 dc	39.67 g	40.08 e	67.85 q	71.79 j	69.81 n	6.25 ef	7.30 c	6.78 c	7.87 hij	6.80 o	7.34 jk
Line 11	38.42 efg	37.52 l	37.97 i	73.37 c	75.42 c	74.40 d	5.06 n	5.15 m	5.10 s	9.39 c	7.33 kl	8.36 fg
Line 12	46.45 a	42.80 c	44.63 a	79.28 a	77.66 a	78.47 a	5.25 l	5.28 l	5.27 q	12.48 a	10.25 b	11.36 a
Line 13	36.15 hi	40.87 f	38.51fgh	70.81 k	66.50 q	68.69o	6.74 b	5.16 m	5.95 k	9.50 c	7.22 l	8.36 fg
Line 14	35.27 ij	36.19 m	35.73 jk	67.39 r	73.14 g	70.27 m	5.75 i	6.87 e	6.31 g	8.26 gh	8.94 d	8.60 e
Mikam2002	33.41 lm	35.42 o	34.41 n	68.90 o	72.91 h	70.90 k	5.09 mn	6.75 f	5.92 k	11.50 b	10.69 a	11.09 b
Line 16	36.13 hi	34.13 r	35.13 lm	73.19 d	77.27 b	75.23 b	5.09 mn	5.35 l	5.22 q	6.98 mn	8.59 e	7.78 i
Line 17	39.41 de	42.61 d	41.01 d	74.16 b	75.32 cd	74.74 c	6.19 fg	6.84 e	6.52 e	8.33 fg	9.45 c	8.89 c
Line 18	34.31 jkl	42.07 e	38.19 h	71.65 i	74.28 e	72.97 h	4.85 o	5.48 k	5.16 r	8.02 ghi	6.57 p	7.29 jkl
Line 19	37.60 g	38.61 i	38.10 h	71.28 j	75.15 d	73.22 f	6.75 b	6.85 e	6.80 c	6.59 no	8.10 h	7.34 jk
Alperbey	33.24 lm	33.48 s	33.36 o	68.59 p	66.73 p	67.66 q	6.18 fg	6.26 g	6.22 h	6.88 mn	7.39 k	7.13 klm
Line 21	35.12 ij	38.37 j	36.75 i	65.10 u	70.50 k	67.80 p	5.24 l	4.88 o	5.06 s	9.45 c	8.46 f	8.89 c
Line 22	38.57 efg	38.99 h	38.78 fg	65.29 t	66.55 q	65.92 t	5.75 i	5.07 n	5.41 p	8.32 fg	8.23 g	8.28 g
Line 23	32.74 m	35.89 n	34.32 n	72.85 e	73.39 f	73.12 g	6.14 g	5.91 i	6.02 j	7.76 ijk	7.24 l	7.50 j
Line 24	30.97 n	34.87 p	32.92 o	63.20 v	69.81 n	66.51 s	5.15 m	5.36 l	5.26 q	8.76 de	8.85 d	8.81 cd
Karma	40.05 d	37.68 k	38.86 f	69.19 n	59.52 s	64.36 v	5.66 j	7.06 d	6.36 f	9.11 dc	7.91 i	8.51 ef
Genotype	**	**	**	**	**	**	**	**	**	**	**	**
Year	**	**	**	**	**	**	**	**	**	**	**	**
Year x Genotype	**	**	**	**	**	**	**	**	**	**	**	**

$^{a, b, c}$, row means with common superscripts do not differ (P>0.05); NS, non-significant; Sig., significance level; * , P<0.05; ** , P<0.01; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; CA, crude ash

Digestibility parameters of the triticale genotypes are provided in Table 7. The differences between entire digestibility parameters were found to be significant (P<0.01). DMD values of the first year varied between 52.71 – 64.78% with the lowest value in L12 and the highest value in L24. The values of the second year varied between 54.28 – 62.82% with the lowest value in L7 and the highest value in cultivar Alperbey. With regard to average of years, DMD values varied between 54.14 – 63.25% with the lowest value in L12 and the highest value in L24. The lowest DMI ratios were obtained from line L12 as of 1.510% in the first year, 1.547% in the second year and 1.528% in the average of years. The highest DMI value was observed in L1 (2.006%) in the first year, in cultivar Karma (2.017%) in the second year

Table 7- Digestibility of triticale genotypes

Çizelge 7- Tritikale genotiplerine ait sindirilebilirlik değerleri

	DMD (%)			*DMI (%)*			*RFV*		
Genotypes	*2011*	*2012*	*Average*	*2011*	*2012*	*Average*	*2011*	*2012*	*Average*
Line 1	56.21 m	55.31 r	55.76 n	2.006 a	1.747 e	1.876 b	87.35 c	74.83 l	81.09 g
Line 2	60.47 g	61.90 c	61.19 de	1.910 c	1.853 b	1.881 a	89.67 b	88.94 b	89.31 a
Line 3	59.48 hi	58.71 k	59.10 hi	1.660 r	1.663 i	1.662 m	76.53 j	75.71 k	76.12 l
Line 4	62.54 bcd	59.57 hi	61.06 ef	1.820 f	1.760 d	1.790 f	88.17 c	81.24 f	84.71 e
Tatlıcak	56.85 lm	56.10 o	56.48 m	1.667 q	1.710 g	1.688 l	73.39 l	74.36 m	73.88 n
Line 6	58.69 ij	55.33 r	57.01 l	1.657 r	1.590 o	1.623 q	75.30 k	68.19 r	71.75 o
Line 7	58.17 jk	54.28 s	56.23 m	1.720 l	1.670 i	1.695 k	77.55 hij	70.32 p	73.94 n
Line 8	62.78 bc	61.02 f	61.90 bc	1.957 b	1.713 g	1.835 c	95.22 a	81.05 f	88.13 b
Line 9	61.89 de	59.51 i	60.70 f	1.700 m	1.593 o	1.647 n	81.51 f	73.57 n	77.54 j
Melez2001	57.36 kl	57.99 m	57.68 k	1.770 h	1.670 i	1.720 i	78.62 h	75.12 l	76.87 k
Line 11	58.97 hij	59.67 h	59.32 h	1.637 t	1.590 o	1.613 r	74.74 k	73.58 n	74.16 n
Line 12	52.71 n	55.56 q	54.14 o	1.510 v	1.547 p	1.528 u	61.84 m	66.53 s	64.18 q
Line 13	60.74 fg	57.07 n	58.91 hij	1.693 n	1.803 c	1.748 h	79.77 g	79.80 g	79.79 h
Line 14	61.43 ef	60.71 g	61.07 ef	1.780 g	1.640 k	1.710 j	84.77 de	77.20 j	80.98 g
Mikam2002	62.87 bc	61.31 e	62.09 b	1.740 j	1.647 j	1.693 k	84.87 de	78.21 h	81.54 g
Line 16	60.75 fg	62.31 b	61.53 cd	1.640 t	1.550 p	1.595 t	77.20 ij	75.00 l	76.10 l
Line 17	58.20 jk	55.71 p	56.96 l	1.620 u	1.590 o	1.605 s	72.99 l	68.78 q	70.89 p
Line 18	62.17 cde	56.13 o	59.15 h	1.673 p	1.617 m	1.645 no	80.69 fg	70.27 p	75.48 m
Line 19	59.61 h	58.82 k	59.22 h	1.680 o	1.600 n	1.640 p	77.78 hi	72.79 o	75.29 m
Alperbey	63.01 bc	62.82 a	62.92 a	1.750 i	1.797 c	1.773 g	85.43 d	87.55 c	86.49 c
Line 21	61.54 ef	59.01 j	60.28 g	1.843e	1.700 h	1.772 g	87.92 c	77.84 i	82.88 f
Line 22	58.86 hij	58.52 l	58.69 ij	1.840 e	1.800 c	1.820 d	83.83 e	81.79 e	82.81 f
Line 23	63.40 b	60.94 f	62.17 b	1.650 s	1.633 l	1.642 op	80.93 f	77.22 j	79.08 ı
Line 24	64.78 a	61.73 d	63.25 a	1.900 d	1.720 f	1.810 e	95.32 a	82.23 d	88.78 a
Karma	57.70 k	59.55 hi	58.63 j	1.733 k	2.017 a	1.875 b	77.56 hij	93.04 a	85.30 d
Genotype	**	**	**	**	**	**	**	**	**
Year	**	**	**	**	**	**	**	**	**
Year x Genotype	**	**	**	**	**	**	**	**	**

[a, b, c] , row means with common superscripts do not differ (P>0.05); NS, non-significant; Sig.,significance level; * , P<0.05; ** , P<0.01; DMD, dry matter digestibility; DMI, dry matter intake; RFV, relative feed value

and in line L2 (1.881%) as the average of years. Considering the RFV values of the genotypes, the lowest values were obtained from L12 in both years and the highest values were obtained from L24 in the first year, cultivar Karma in the second year and L2 in the average of years.

Similarity levels varied between 0.06-1.90 and there were two main groups (A and B). The first group (A) was composed of 12 triticale lines and the lines in this group (Line2, Line16, Melez 2001, Line14, Alperbey, Line4, Line18, Line12, Line22, Line24, Line6 and Line8) were separated from the second group (B) with a similarity level of 0.78. Genetically, the Line14 and Alperbey genotypes were found to be 99% similar with each other. The first group was divided into two sub-groups (A.1 and A.2) with a similarity level of 0.70. The sub-group A.1 was composed of Line8 and Line 6 with a similarity level of 0.53.

The second group (B) was composed of 13 triticale lines and separated from the first group (A) with a similarity level of 0.55. The second group was also divided into two sub-groups (B.1 and B.2) with a similarity level of 0.57. The first sub-group of the second group (B.1) was separated from the second sub-group (B.2) with a similarity level of 0.57. Only the Line 23 was placed into the B.1 and the lines Line1, Line13, Line3, Line9, Line11, Line19, Line21, Line7, Karma, Mikam 2002, Tatlıcak, Line17 and L23 were placed into the B.2. Within B.2, the lines Line11 and Line19 were the closest lines to each other and they separated from each other with a similarity level of about 0.10 (Figure 1).

Precipitations of the experimental years 2011-2012 and 2012-2013 were significantly different from each other. Especially the lower precipitations during March and April of the first year and higher precipitations of the second year significantly effected yields and chemical compositions and resulted in significant differences between these parameters. Different plant growth levels in March and April and different responses against water deficits resulted in significant year x genotype interaction.

Herbage values of the present study were higher than the values reported by Kaplan et al (2011) and similar to the values reported by Lithourgidis et al (2006) and Surmen et al (2011). Hay yields of the current study were similar to the ones reported by Delogu et al (2002); Albayrak et al (2006); Mut et al (2006) and Kaplan et al (2011); and higher than the values of Lithourgidis et al (2006). Such differences in hay yields were mainly due to differences in climate conditions and different responses of genotypes against different conditions. These differences may also result from higher nutrient accumulation levels of early-spiking plants (Delogu et al 2002).

Crude protein content is an essential parameter to evaluate the quality of forages (Caballero et al 1995; Assefa & Ledin, 2001). Differences in dry matter and crude protein contents usually come from the genetic characteristics of plants but spike-shoot ratio, growing period, temperature and fertilizers are also effective on both parameters (Ball et al 2001). While protein yields of the present study were similar to values reported by Kaplan et al (2011); Lithourgidis et al (2006); Surmen et al (2011) and Mut et al (2006), crude protein ratios were similar

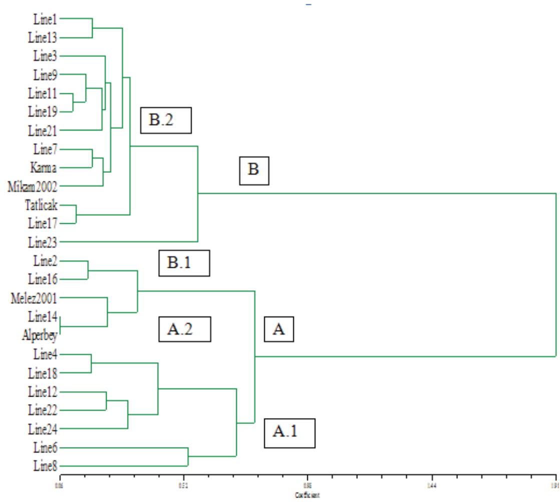

Figure 1- The dendrograms for new triticale lines and cultivars

Şekil 1- Yeni tritikale hat ve çeşitlerine ait dendogram to the values of Bilgili et al (2009); Schwarte et al (2005); Delogu et al (2002); Ozdüven et al (2010); Kaplan et al (2011) and Canbolat (2012).

Increase in NDF and ADF contents slow down digestion, physically allow the animal to feel full and limit the feed consumption of animals. Therefore, both parameters are desired at low levels in feed rations (Van Soest 1994; Bozkurt 2011; Canbolat & Karaman 2009). ADF values of the current study were higher than the ones reported by Lekgari et al (2008); Kaplan et al (2011) and Canbolat (2012) but similar to the ones reported by Lithourgidis et al (2006); Surmen et al (2011) and Özdüven et al (2010). NDF values were higher than the values of Lithourgidis et al (2006); Lekgari et al (2008); Kaplan et al (2011) and Canbolat (2012) but similar to values of Surmen et al (2011); Karadağ & Buyukburç (2004) and Ozduven et al (2010). Ash content of the present study were similar to values reported by Mut et al (2006) and Canbolat (2012) but higher than the ones reported by Kaplan et al (2011).

Increase in cell wall components (ADF and NDF) limits the digestibility of feeds and consequently negatively affects RFV (Table 5). Compared to a reference value of 100 for alfalfa at full-flowering period, 3 of triticale lines (L2, L8 and L24) were classified as 3rd quality, 16 of them (L1, L3, L4, L9, Melez 2001, L13, L14, Mikam 2002, L16, L18, L19, Alperbey, L21, L22, L23 and Karma) were classified as 4th quality, 6 of them (Tatlıcak, L6, L7, L11, L12 and L17) were classified as 5th quality (Rohweder et al 1978). DDM values of the present study were similar but DMI values were lower than the values of Lithourgidis et al (2006). RFV values of the current study were lower than the values reported by Lekgari et al (2008) and Lithourgidis et al (2006) and similar to ones reported by Surmen et al (2011).

4. Conclusions

Two-year experiments on hybrid new triticale genotypes revealed that the lines had superior characteristics with regard to investigated parameters over the standard registered cultivars. The line L4 was prominent with herbage yield and the cultivar Melez 2001 was also placed into the highest group. Considering the hay yield, the genotypes L4, L8, L13, L16 and L19 were prominent and had better outcomes than registered cultivars. The line L12 had the highest protein yield and protein ratio. The line L2 was found to be prominent with dry matter intake and RFV and line L24 with regard to only RFV. In general, when the yield and quality parameters are evaluated together, especially the line L4 was found to be promising with its herbage, hay and protein yields per hectare and the line L2 was found to be promising with its relative feed value and dry matter intake. Also, the other lines with prominent different characteristics may also be used as rootstock in further breeding studies.

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