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Evaluation of Oat (*Avena sativa* L.) Genotypes for Green Forage, Hay Yield and Some Quality Parameters in Trakya-Marmara Region

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ABSTRACT

This study was carried out during the 2016-17 and 2017-18 growing seasons in Edirne. This study was conducted in a randomized complete block design with four replications. The five varieties (Kirklar, Kahraman, Kucukyayla, Yeniceri and Sebat) and 10 lines were used as material in the study. It was aimed to determine the genotypes suitable for animal nutrition. The traits such as green forage (GFY) and hay yield (HY), plant height (PH), acid detergent fiber (ADF), neutral detergent fiber (NDF) and crude protein content (CP) as well as dry matter digestibility (DMD), dry matter consumption (DM) and relative feed value (RFV) quality parameter performances of the genotypes were investigated. There were statistically significant differences among genotypes for green forage, hay yield and plant height. The effects of genotype x year interaction on green forage, hay yield and plant height were found statistically significant. According to the results of two years of research, correlations between hay yield with green forage (0.8865**) and plant height (0.6141**) were determined as significant and positive. In terms of two years average, GFY, HY, PH, ADF, NDF, CP and RFV of oat lines ranged between 39.90-56.69 (50.84 t ha^{-1}), 10.52-15.09 (12.93 t ha^{-1}), 84.4-105.4 (95.8 cm), 36.0-44.0 (39.7%), 50.6-59.0 (55.1%), 8.9-17.2 (12.6%) and 86.1-108.3 (98.2%). The oat G6 had the highest hay yield with 15.18 t ha^{-1} and G8 had highest RFV with 107.8%. G2 (Kahraman), the oat G9 and G8 were suitable for hay yield and RFV in Trakya-Marmara region.

Field Crops

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Trakya-Marmara Bölgesinde Yulaf (*Avene sativa* L.) Genotiplerinin Yeşil Ot, Kuru Ot ve Bazı Kalite Özellikleri Yönünden Değerlendirilmesi

ÖZET

Bu çalışma, 2016-17 ve 2017-18 üretim sezonlarında Tesadüf Blokları Deneme Deseninde dört tekerrürlü olarak Edirne'de yürütülmüştür. 15 yulaf genotipin kullanıldığı denemede, 5 standart çeşit (Kırklar, Kahraman, Küçükyayla, Yeniçeri ve Sebat) yer almıştır. Araştırmada, yulaf genotiplerin yeşil ot ve kuru ot verimi ile bazı kalite özellikleri incelenerek hayvan beslemesi için bölgeye uygun genotiplerin belirlenmesi amaçlanmıştır. Bu kapsamda genotiplerin yeşil ve kuru ot verimi, bitki boyu ile kalite özelliklerinden ADF(Asit Deterjan Lif), NDF (Nötral Deterjan Lif), HP (Ham Protein), KMS (Kuru Madde Sindirebilirliği), KMT (Kuru Madde Tüketimi) ve NYD (Nispi Yem Değeri) incelenmiştir. Yapılan araştırma sonucunda iki yılda da yeşil ot verimi, kuru ot verimi ve bitki boyları arasında genotipler arasındaki fark istatistiki olarak önemli bulunmuştur. Ayrıca ADF, NDF, HP, KMS, KMT ve NYD yönünden genotipler arasında farklılıklar belirlenmiştir. Genotip x yıl interaksiyonunun genotiplerin yeşil ot, kuru ot ve bitki boyu üzerine etkilerinin istatistiki olarak önemli bulunmuştur. İki yıllık çalışma sonucuna göre genotiplerin kuru ot verimi ile yeşil ot verimi (r=0.8865**) ve bitki boyu (r=0.6141**) arasında pozitif ve önemli bir

Tarla Bitkileri

Araştırma Makalesi

Makale Tarihçesi
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Anahtar Kelimeler
Ham Protein
Yem Kalitesi
Kuru ot verimi
Nisbi Yem değeri
Çeşit

ilişki belirlenmiştir. İki yıl ortalamasına göre genotiplerin yeşil ot verimi; 39.90-56.69 (50.84) t ha^{-1}, kuru ot verimi; 10.52-15.09 (12.93) t ha^{-1}, bitki boyu; 84.4-105.4 (95.8) cm, ADF; %36.0-44.0 (39.7), NDF; %50.6-59.0 (55.1), HP; %8.9-17.2 (12.6), KMS; %2.0-2.4 (2.2), KMT; %54.6-60.8 (58.0) ve NYD; %86.1-108.3 (98.2) arasında değişim göstermiştir. İki yıllık çalışma sonucunda 15. 18 t ha^{-1} kuru ot verimi ile 6 nolu genotip, %107.8 NYD ile 8 nolu genotip en kaliteli olarak öne çıkmıştır. Kuru ot verimi ve nispi yem değeri yönünden Kahraman, 9 ve 8 nolu genotipler bölge için en uygun olarak öne çıkmıştır.

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INTRODUCTION

Oat (*Avena sativa* L.) is an important cereal for human nutrition and animal feed across the world (Buerstmayr, 2007). Oat stems are softer and leaves are more abundant, so they are rich in organic and mineral substances from wheat and barley straw. Besides, oat is used to support the mixture of legumes such as grain, green forage, silage, straw and vetch-feed peas. Among the cereals, oat has the highest protein content and quality in the feeding of domestic animals. The oat also shows the highest oil content. Oat green were grown on an area of 82.551 ha in 2012 and 214.257 ha in 2018 in Turkey. At the same time, green forage production was recorded 934.157 t in 2012 and as 2.843.686 t in 2018. The yield per area should be increased to fill the gap of higher quality forage in Turkey (Avcıoğlu et al., 2000). 17 oat varieties (Faikbey, Seydisehir, Sebat, Yeniceri, Sari, Fetih, Kirklar, Kahraman, Haskara, Albatros, Bc Marta, Dirilis, Arslanbey, Kucukyayla, Kehlibar, Kayi and Kupa) have been registered in Turkey (Anonim, 2019). All of these varieties are cultivated for grain. Oat is important in the feeding of farm animals due to the high protein content (Wood, 2001). Cheap and easily available feed sources are required in order to increase animal production, and oat is an important alternative plant. Oat is a priority product in the world as animal food, and it is inevitable to increase its production if the importance of oats in animal nutrition is taken into account in our country (Serin and Tan, 2009). Koçer and Albayrak (2012), investigated feed peas mixtures with oat and barley. They reported hay yield as 13.52 t ha^{-1}, ADF value as 34.6%, NDF value as 59.1% and CP as 10.87%. and RFV as 97.45% for monoculture oat and RFV as 167.27% for monoculture feed peas. As the feed pea ratio increased, the relative feed value of the feed increased. Avci (2017), used 13 oat genotypes and reported green forage yield 55.65 t ha^{-1} oat sowing during winter and 37.39 t ha^{-1} in summer. While they obtained hay yield as 12.64 t ha^{-1} in winter, they obtained hay yield as 6.88 t ha^{-1} in the summer. Mut et al. (2015), tested 100 oat genotypes and reported CP ranged from 5.88-13.64%, ADF values ranged from 33.32-42.48% and NDF values ranged from 52.25-65.24%. Çeri and Acar (2019), used 12 oat genotypes and they obtained green forage yield between 23.42-31.09 t ha^{-1}, hay yield between 6.14-9.94 t ha^{-1}, ADF value varied between 37.82-41.75%, NDF between 52.79-57.80% and CP between 9.64-11.53%. This study tested the 15 oat genotypes (10 oat lines and 5 varieties) developed by Trakya Agricultural Research Institute for green forage and hay yield, as well as some quality characteristics to determine the accessions suitable for the Trakya-Marmara region.

MATERIALS and METHODS

This research was conducted in Edirne Trakya Agricultural Research Institute during the 2016-17 and 2017-18 growing seasons. Five standard varieties (Kirklar, Kahraman, Kucukyayla, Yeniceri and Sebat) and ten oat lines were used. According to the results of some physical and chemical analysis of the soil in which the research was conducted, the texture class was silty-clay loam, organic matter content 1.07%, lime content 0.00%, salt 0.05%, pH 6.20, available phosphorus amount 279.2 kg ha^{-1}, potassium content was 968.0 kg ha^{-1}. The climatic values of the research site for trial years were given in Table 1. While the total rainfall was 417.2 mm in 2016-2017, 833.8 mm in 2017-2018. The mean temperature of the trial was 12.0 ^{0}C in 2016-17, 10.2 ^{0}C in 2017-18. Due to the high temperature in the first year, the flowering date of plants were 10-15 days earlier than in the second year. However, in the second year of the trial, especially April rainfall was insufficient (3 mm). The lack of rainfall in this period negatively affected the plant height, green forage and hay yield. Although the flowering date was delayed in the first year of the experiment, as a result of sufficient rainfall in April (65.6 mm) and May (85 mm), the plant height, green forage and hay yields were the same as in the second year. The experiment was carried out with four replications according to the Randomized Complete Block Design. Each plot consisted of six rows of 7 m length and 1 m width and line spacing 17 cm. Seeding rate and field management were determined according to the results of regional research, with about 600 seeds per m².

Table 1. Rainfall (mm), mean temperature (⁰C) and relative humidity (%) of the research site*

Çizelge 1. Araştırma yerinin yağış miktarı (mm), ortalama sıcaklık (8) ve nispi nem (%) değerleri

	Total Rainfall (mm)		Mean Temperature (⁰C)		Relative Humidity (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
September	9.2	34.2	20.8	21.3	57.5	57.8
October	44.4	135.2	14.3	13.6	69.5	77.1
November	3.2	71.6	0.7	9.5	72.9	75.7
December	3.2	119.6	0.7	7.4	72.9	85.1
January	67.8	55.6	-1.9	4.3	83.7	88.1
February	43.4	101.8	5.3	5.7	80.0	89.5
March	51.0	145.6	10.2	8.9	73.0	88.8
April	65.6	3.0	12.5	16.6	63.1	61.3
May	85	18.8	17.9	20.3	65.4	76.3
June	44.4	148.4	21.2	22.6	74.4	66.4
Total	417.2	833.8				
Mean			10.2	12.0	71.2	76.6

* Values were taken from Edirne Meteorology Directorate

** Veriler Edirne Metereoloji Müdürlüğünden alınmıştır*

The experiment was carried out with four replications according to the Randomized Complete Block Design. Each plot consisted of six rows of 7 m length and 1 m width and line spacing 17 cm. Seeding rate and field management were determined according to the results of regional research, with about 600 seeds per m^{-2}. The trials were planted on 19 October 2016 in the first year and on 18 October 2017 in the second year. Sowing was done with a specific seeder for plots. Before planting, 20-20-0 composite fertilizer (about 40 kg ha^{-1} of P2O5, 4 kg ha^{-1} of N) was broad-casted and incorporated. An additional of N was top-dressed 70 kg ha^{-1} at tillering stage and 40 kg ha^{-1} stem elongation stage. Weeds were controlled by Glean herbicide (about 10 cc ha^{-1}) before germination and Lancelot super herbicide (about 30 cc ha^{-1}) at the end of tillering stage. The plants were cut with a special rice machine at 50% flowering in each plot (6 m^{-2} area). The trials were cut between 1 May and17 May 2017 in the first year and between 22 April and 4 May 2018 in the second year. In the harvest, plots were evaluated as 6mx1m = 6 m^{-2} area.

Green forage yield (t ha^{-1}): The plants are cut and weighed when there is 50% flowering in each plot.

Hay yield (t ha^{-1}): After weighing the green forage harvested from each plot, samples of 0.5-1 kg green forage were dried in a drying cabinet at 70 ⁰C for 48 h (Ünal, 2011), dried plants are kept at room temperature for 24 hours, and then weighted with precision balance (0.05 g).

Crude Protein Content (%): Crude protein content was determined by AOAC method (nitrogen multiplied by 6.25 was determined by device LECO FP 528) (Anonymous, 2009).

Insoluble Fiber in Neutral Detergent Solution (NDF) (%): It forms the insoluble part of neutral detergent in oat forage samples. It contains hemicellulose, cellulose, lignin and silica. Oat samples were determined by Spectrastar 2400D, Unity Scientific, USA NIR brand method (Van Soest et al., 1991).

Insoluble Fiber in Acid Detergent Solution (ADF) (%): It is composed of insoluble parts of oat grass samples under acid detergent conditions. It contains cellulose, lignin and silica. Oat samples were determined using the Spectrastar 2400D, Unity Scientific, USA NIR device according to the method (Van Soest et al., 1991).

Relative Feed Value (RFV) (%): It was calculated by using the formula (120)/NDF) x ((88.9- (0.779 x ADF)) x (0.775)).

Total Digestible Food (TDN) (%): It was calculated by using the ((-1.291 x ADF) +101.35) formula. DMD and DM of feeds were determined using below the equations (Van Dyke and Anderson, 2000). DMD value were determined using ADF values (Kaya, 2008).

DMD = 88.9 - (0.779 x ADF), DM = 120 / NDF, NYD = DMD x DM x 0.775

The data were analyzed with JMP (5.0) statistical software. According to the variance analysis results, statistically significant factor averages were compared using the Least Significant Difference (LSD) (Kalaycı, 2005).

RESULTS and DISCUSSION

Green forage yields of genotypes were 37.88-63.50 t ha^{-1} in the first year and 41.92-55.54 t ha^{-1} in the second year, while the average green forage yield was 51.28 t ha^{-1} in the first year and 50.40 t ha^{-1} in the second year (Table 2-3). Based on the two-year averages of results, green forage yields of genotypes ranged from 39.90- 56.69 t ha^{-1}. While the highest green forage yield were obtained from G4 (Sebat) (56.69 t ha^{-1}) and G6 (56.60 t ha^{-1}) the lowest green forage yield were obtained from G5 (Yeniceri) (39.90 t ha^{-1}) and G7 (41.83 t ha^{-1}). Acar (1995), obtained oat yield as 11.49 t ha^{-1}, Gül et al. (1999) reported oat forage yield 16.82-28.48 t ha^{-1}. Uzun and Aşık (2012), reported the highest of green forage yield 47.34 t ha^{-1}.

Table 2. Mean square (MS) from the coşıkined analysis of variance for green forage yield, hay yield and plant height of oat genotypes
Çizelge 2. Yulaf genotiplerinin yeşil ot verimi, kuru ot verimi ve bitki boylarının birleştirilmiş varyans analizlerinin ortalama kareleri

Source of Variation	DF	GFY	HY	PH
Years (Y)	1	8.39523	0.13213	385.208
Replication [Yrs]	6	114.214	7.7099	441.608
Genotypes (G)	14	79.7125**	5.01841**	336.619**
Y x G	14	34.9702**	6.06818**	97.119**
Error	84	7.8713	0.52366	15.388
Total	119	24.87754	2.06379	87.39321

Significant at *p<0.05. and **p<0.01 levels. Respectively, **GFY**: Green forage yield, **HY**: Hay yield, **PH**: Plant height
*Önemlilik *p<0.05 ve **p<0.01 seviyeleri. Yeşil ot verimi, Kuru ot verimi, Bitki boyu*

Table 3. Yields of green forage and hay of the 15 oat genotypes during the 2016-17 and 2017-18 growing seasons
Çizelge 3. Yulaf genotiplerinin 2016-17 ve 2017-18 yetiştirme sezonlarındaki yeşil ot ve kuru ot verimi ortalama değerleri ve gruplar

	Genotypes	Green forage yield (t ha^{-1})			Hay yield (t ha^{-1})		
G. No	Genotype or Pedigree	2016-2017	2017-2018	2016-2018	2016-2017	2017-2018	2016-2018
G6	IL 3555-0BD-0T-5T-0T	61.92±3.70 a	51.29±3.50 a	56.60±6.58 a	17.28±1.03 a	13.08±0.89 b-e	15.18±2.41 a
G4	Sebat (st)	57.83±5.36 a-c	55.54±7.79 a	56.69±6.31 a	14.92±1.38 b	14.33±2.01 a-c	14.63±1.63 ab
G13	MN06130-0BD-0T-1T-0T	63.50±3.48 a	49.00±9.30a-c	56.25±10.1 a	16.89±0.93 a	11.42±2.17 ef	14.15±3.31 a-c
G2	Kahraman (st)	44.13±3.55 gh	52.00±11.3 a	48.06±8.80 de	12.93±1.04 cd	14.72±3.19 ab	13.82±2.39 b-d
G10	FL0507-0BD-0T-0T-9T-0T	53.0.0±5.54 c-e	53.71±8.47 a	53.35±6.64 a-c	13.94±1.46 bc	13.64±2.15 a-d	13.79±1.71 b-d
G9	FL0507-0BD-0T-0T-1T-0T	49.96±4.03 d-f	54.67±3.56 a	52.31±4.33 a-d	11.49±0.93 e-g	15.09±0.98 a	13.29±2.12 c-e
G12	MN06203-0BD-0T-2T-0T	57.92±0.88 a-c	55.13±6.95 a	56.52±4.82 a	12.86±0.19 c-e	13.34±1.68 a-e	13.10±1.14 c-f
G8	FL0522-0BD0T-0T-10T-0T	58.92±3.49 ab	48.67±11.9 a-c	53.79±9.82 ab	13.49±0.80 b-d	12.70±3.12 c-e	13.10±2.15 c-f
G1	Kirklar (st)	48.85±3.47 e-g	48.67±8.10 a-c	48.76±5.77 c-e	12.95±0.92 cd	13.09±2.18 b-e	13.02±1.55 c-f
G11	MN05131-0BD-0T-5T-0T	55.67±3.14 b-d	49.54±6.01 ab	52.60±5.52 a-d	14.14±0.80 bc	11.40±1.38 ef	12.77±1.80 d-f
G3	Kucukyayla (st)	44.58±6.05 f-h	50.54±8.44 ab	47.56±7.51 e	10.39±1.41 gh	13.85±2.31 a-d	12.12±2.56 e-g
G15	FL0534-0BD-0T-0T-1T-0T	43.04±3.00 hı	51.08±7.15 a	47.06±6.65 e	9.94±0.69 h	13.95±1.95 a-d	11.94±2.53 fg
G14	FL06020-0BD-0T-0T-3T-0T	51.88±9.00 de	50.83±5.68 ab	51.35±6.99 b-e	12.29±2.13 d-f	10.52±1.18 f	11.41±1.86 gh
G7	FL04167-0BD-0T-0T-9T-0T	40.21±4.77 hı	43.46±8.28 bc	41.83±6.49 f	11.14±1.32 f-h	11.39±2.17 ef	11.26±1.67 gh
G5	Yeniceri (st)	37.88±2.92 ı	41.92±7.30 c	39.90±5.58 f	8.48±0.65 ı	12.28±2.14 d-f	10.38±2.50 h
Average		51.28±8.77	50.40±7.88	50.84±8.31	12.88±2.56	12.99±2.24	12.93±2.39
CV (%)		7.86	10.4	9.20	7.79	10.6	9.33
LSD (% 5)		5.75	7.48	4.65	1.43	1.96	1.20
		Year: 7.96 not significant Yıl : Önemsiz			Year: 2.07 not significant, Yıl: Önemsiz		
		Genotype x Year: Significant, Genotip x Yıl: Önemli			Genotype x Year: Significant, Genotip x Yıl: Önemli		

*Means marked with the same letter are no different from each other.
**Aynı harfli olanlar birbirinden farklı değildir*

Avcı (2017), used 13 oat genotypes and reported as 55.65 t ha^{-1} oat sowing during winter and 37.39 t ha^{-1} in summer. On the other hand, Çeri and Acar (2019), used 12 oat genotypes and they obtained green forage yield as 23.42-31.09 t ha^{-1}. As it is seen, summer yields have declined of Çeri and Acar (2019) because oat plant likes cool and rainy weathers.Our results are similar to results of Avcı (2017), Uzun and Aşık (2012). However, our results were not similar to the other studies of Acar (1995), Gül et al. (1999), because the material used was different and the studies were conducted in different locations.

Hay yields of genotypes varied between 8.48-17.28 t ha^{-1} in the first year and 10.52-15.09 t ha^{-1} in the second year. In the first year, genotype G6 reached the highest hay yield (17.28 t ha^{-1}), followed by G4 and number G13 as 16.89 t ha^{-1} and 14.92 t ha^{-1}, respectively. According to the average of two years, the highest hay yield was reached in G6 with 15.18 t ha^{-1}. It is followed by G4 variety with 14.63 t ha^{-1} and G13 with 14.15 t ha^{1}.

There was statistically significant difference in green forage and hay yields of genotype and genotype x year interaction, while there was no statistically significant difference in green forage and hay yields of genotypes between years. According to the results of two years of research, correlations between hay yield with green forage (0.8865**) were determined as significant and positive. Gül et al. (1999), stated hay yield as 7.05-8.27 t ha^{-1}, Koçer and Albayrak (2012) stated as 13.52 t ha^{-1} in their study. Avcı (2017) used 13 oat genotypes for winter sowing. While they obtained hay yield as 12.64 t ha^{-1} in winter, they obtained hay yield as 6.88 t ha^{-1} in the summer. Çeri and Acar (2019) used 12 oat genotypes and they ranged from hay yield between 6.14-9.94 t ha^{-1} in their study. Our results were similar to those of Avcı (2017), Koçer and Albayrak (2012), but were different from those of Gül et al. (1999) and Çeri and Acar (2019). The reason why the results were not similar was that the materials and experiments used were conducted in different regions. The data on plant height and flowering dates of genotypes are given (Table 4).

Table 4. Values of plant height and flowering date of the 15 oat genotypes during the 2016-17 and 2017-18 growing seasons.
Çizelge 4. Yulaf genotiplerinin 2016-17 ve 2017-18 yetiştirme sezonlarındaki bitki boyu ortalama değerleri, grupları ve başaklanma tarihleri

G. No	Genotype or Pedigree	Plant Height (cm) 2016-2017	2017-2018	2016-2018	Flowering Date (day/month) 2016-2017	2017-2018
G1	Kirklar (st)	91.8±4.92 d	101.3±10.30 b-d	96.5±9.04 bc	3/5	24/4
G2	Kahraman (st)	87.8±2.22 e	96.5±7.94 c-f	92.1±7.14 d	4/5	25/4
G3	Kucukyayla (st)	80.8±2.98 f	88.0±8.52 g	84.4±7.07 e	1/5	24/4
G4	Sebat (st)	88.8±2.22 de	87.3±5.31 g	88.0±3.85 e	15/5	04/5
G5	Yeniceri (st)	83.3±2.75 f	89.8±8.77 fg	86.5±6.94 e	6/5	30/4
G6	IL 3555-0BD-0T-5T-0T	105.0±1.41 b	101.5±4.43 b-d	103.3±3.57 a	9/5	27/4
G7	FL04167-0BD-0T-0T-9T-0T	89.5±2.64 de	96.3±7.41 d-f	92.9±6.29 cd	4/5	27/4
G8	FL0522-0BD0T-0T-10T-0T	97.8±3.30 c	92.0±1.87 e-g	94.9±9.37b-d	17/5	03/5
G9	FL0507-0BD-0T-0T-1T-0T	102.5±5.74 b	107.8±3.30 ab	105.1±5.16 a	5/5	26/4
G10	FL0507-0BD-0T-0T-9T-0T	96.3±0.95 c	109.3±10.04 a	102.8±9.58 a	3/5	22/4
G11	MN05131-0BD-0T-5T-0T	97.3±0.48 c	93.3±6.55 e-g	95.3±4.94b-d	14/5	03/5
G12	MN06203-0BD-0T-2T-0T	97.3±1.89 c	98.8±16.58 c-e	98.0±10.95 b	15/5	02/5
G13	MN06130-0BD-0T-1T-0T	109.0±2.58 a	101.8±8.18 b-d	105.4±6.82 a	12/5	28/4
G14	FL06020-0BD-0T-0T-3T-0T	95.5±1.29 c	97.0±8.04 c-e	96.3±5.39 bc	4/5	24/4
G15	FL0534-0BD-0T-0T-1T-0T	87.8±0.25 e	103.5±6.24 a-c	95.6±9.34b-d	5/5	28/4
Average (Year)		94.0±8.12	97.6±10.2	95.8±9.34		
CV (%)		2.66	5.08	4.10		
LSD (% 5)		3.56	7.07	3.90		

Year: No significant, Genotype x Year: Significant
Yıl: Önemsiz, Genotipx Yıl: Önemli

There was statistically significant difference on plant height of genotype and genotype x year interaction, while there was no statistically significant difference on plant height of genotypes between years. According to the results of two years of research, correlations between hay yield with plant height (0.6141**) were determined as significant and positive. Taller oat plants are preferred for green forage production. The taller the plant height, the higher the yield of green forage and hay yield. Like plant height, stem thickness and amount of leaves are very important in green forage and hay yield. However, too tall plants can lodge and this leads to loss of yield. Moderate tall plants should be preferred for resisting to lodging. In addition, yield losses occur due to lodging during seed production of tall varieties.

Plant height of the genotypes varied from 83.3-109.0 cm in the first year and 87.3-109.3 cm in the second year. According to the year averages plant height of genotypes varied from 84.4-105.4 cm. The tallest plant length were recorded G13 (105.4 cm), G9 (105.1 cm) and G6 (103.3 cm) while the shortest plant height were recorded G3 (Kucukyayla) (84.4 cm) and G5 (86.5cm) according to the average of two years. The genotypes flowered between May 1 and May 17 in the first year and between April 22 and May 3 in the second year. G3, G10, G1 (Kirklar) and G2 (Kahraman) varieties were determined as the earliest flowering while G8, G11, G12 and G4 were determined as the latest flowering. Early flowering is very important in oat green forage and hay yield especially for second crop farming. The ADF, NDF and CP values of the genotypes are shown in Table 5. ADF refers to the amount of cellulose, lignin and insoluble protein in the plant cell wall structure. It provides the digestibility of the feed and the energy intake of the animal.

Table 5. Values of ADF, NDF and CP of the 15 oat genotypes during the 2016-17 and 2017-18 growing seasons
Çizelge 5. Yulaf genotiplerinin 2016-17 ve 2017-18 yetiştirme sezonlarındaki ADF (Asit Deterjan Lif) , NDF (Nötral Deterjan Lif) ve HP (Ham Protein) değerleri

		ADF (%)		NDF (%)		CP (%)	
G. No	**Genotype or Pedigree**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
G1	Kirklar (st)	41.4	40.8	57.4	57.3	14.6	13.4
G2	Kahraman (st)	39.2	39.2	53.9	55.8	17.2	10.9
G3	Kucukyayla (st)	39.6	37.3	53.9	54.4	17.2	8.9
G4	Sebat (st)	40.4	41.7	58.0	56.5	11.8	10.0
G5	Yeniceri (st)	36.0	38.1	52.6	53.3	14.2	10.1
G6	IL 3555-0BD-0T-5T-0T	44.0	39.4	59.0	54.5	12.2	10.3
G7	FL04167-0BD-0T-0T-9T-0T	40.5	39.2	55.3	55.8	16.3	13.1
G8	FL0522-0BD0T-0T-10T-0T	38.5	37.3	50.6	51.8	14.4	13.0
G9	FL0507-0BD-0T-0T-1T-0T	37.5	40.2	54.5	57.2	15.2	11.1
G10	FL0507-0BD-0T-0T-9T-0T	41.3	43.3	57.9	57.5	11.8	12.7
G11	MN05131-0BD-0T-5T-0T	38.0	41.0	52.1	53.0	11.9	10.3
G12	MN06203-0BD-0T-2T-0T	40.6	40.5	55.4	52.7	12.6	11.5
G13	MN06130-0BD-0T-1T-0T	39.9	39.9	57.3	53.5	11.9	11.9
G14	FL06020-0BD-0T-0T-3T-0T	40.6	39.3	54.6	55.0	12.7	12.4
G15	FL0534-0BD-0T-0T-1T-0T	37.9	38.2	56.5	54.0	11.2	13.2
Minimum		36.0	37.3	50.6	51.8	11.2	8.9
Maximum		44.0	43.3	59.0	57.5	17.2	13.4
Average		39.7	39.7	55.3	54.8	13.7	11.5

High content feeds have low digestibility and energy (Kaya, 2008). ADF values of genotypes ranged from 36.0-44.0% and 37.3-43.3% in the first and the second year, respectively. G5 showed the lowest ADF value

(36.0%), while G6 showed the highest ADF value (44.0%) in the first year. G3 had the lowest (37.3%) and G10 had the highest (43.3%) ADF value in the second year. Feed quality of forage is better if ADF is low. Therefore, G8, G15 and G3 are considered good in terms of forage quality. Koçer and Albayrak (2012), stated that ADF value is 34.6%, Mut et al. (2015), used 100 oat genotypes in their study and they founded that ADF values ranged from 33.32-42.48%. Çeri and Acar (2019), used 12 oat genotypes and they determined that ADF value varied between 37.82-41.75%. Our results were similar to Çeri and Acar (2019), Koçer and Albayrak (2012), Mut et al. (2015). NDF value is considerably important because the amount of metabolizing energy in cereal depends on its concentration. The soluble substances in NDF consist mostly of starch, sugar, crude protein and fat. These substances are 98% digestible. However, as the amount of NDF increases, soluble substances contained in NDF decrease. G8 had the lowest NDF (50.6%) and G6 had the highest NDF (59.0%) in the first year. G8 had the lowest NDF (51.8%) and G10 had the highest (57.5%) in the second year. Similar to ADF value, if NDF value is low, forage quality is better. Thus, G8, G11, G5 and G3 varieties were considered to be good. Koçer and Albayrak (2012) reported 59.1% NDF. Mut et al. (2015) found 52.25-65.24% NDF value. Çeri and Acar (2019) investigated 12 oat genotypes and reported NDF as 52.79-57.80%. Our results were similar to Ceri and Acar (2019), Koçer and Albayrak (2012), while Mut et al. (2015) results were slightly different. These differences could be due to the genetic structure of the genotypes, growing conditions and nitrogen fertilizer applications. Oats used as human nutrition and animal feed should have a high protein content.

Table 6. Values of DMD, DM and RFV the 15 genotypes during the 2016-17 and 2017-18 growing seasons.
Çizelge 6. Yulaf genotiplerinin 2016-17 ve 2017-18 yetiştirme sezonlarındaki KMS (Kuru Madde Sindirebilirliği), KMT (Kuru Madde Tüketimi) ve NYD (Nispi Yem Değeri) değerleri

		DMD (%)		DM (%)		RFV (%)	
G. No	**Genotype or Pedigree**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
G1	Kirklar (st)	2.1	2.1	56.7	57.1	91.9	92.7
G2	Kahraman (st)	2.2	2.1	58.4	58.3	100.9	97.2
G3	Kuçukyayla (st)	2.2	2.2	58.1	59.9	100.2	102.4
G4	Sebat (st)	2.1	2.1	57.5	56.4	92.2	93.0
G5	Yeniceri (st)	2.3	2.2	60.8	59.2	107.7	103.2
G6	IL 3555-0BD-0T-5T-0T	2.0	2.2	54.6	58.2	86.1	99.4
G7	FL04167-0BD-0T-0T-9T-0T	2.2	2.2	57.4	58.3	96.5	97.3
G8	FL0522-0BD0T-0T-10T-0T	2.4	2.3	58.9	59.8	108.3	107.4
G9	FL0507-0BD-0T-0T-1T-0T	2.2	2.1	59.7	57.6	102.0	93.7
G10	FL0507-0BD-0T-0T-9T-0T	2.1	2.1	56.7	55.1	91.2	89.2
G11	MN05131-0BD-0T-5T-0T	2.3	2.3	59.3	57.0	105.9	99.9
G12	MN06203-0BD-0T-2T-0T	2.2	2.3	57.3	57.3	96.2	101.3
G13	MN06130-0BD-0T-1T-0T	2.1	2.2	57.8	57.8	93.9	100.6
G14	FL06020-0BD-0T-0T-3T-0T	2.2	2.2	57.3	58.3	97.5	98.7
G15	FL0534-0BD-0T-0T-1T-0T	2.1	2.2	59.4	59.2	97.8	101.8
Minimum		2.0	2.1	54.6	55.1	86.1	89.2
Maximum		2.4	2.3	60.8	59.9	108.3	107.4
Average		2.2	2.2	58.0	58.0	97.9	98.5

While the crude protein values of genotypes ranged between 11.2-17.2% in the first year and 8.9-13.4% in the second year, the mean crude protein content was 13.7% in the first year and 11.5 5 in the second year. In the first year, G2 and G3 varieties reached the highest value with 17.2% protein content, while G15 reached the lowest value with 11.2% protein. In the second year, G2 was the highest with 13.4% crude protein content. There have been high differences in the amount of crude protein in the genotypes. Koçer and Albayrak (2012), stated 10.87% crude protein content. Mut et al. (2015), tested 100 oat genotypes and reported 5.88-13.64% crude protein content. Çeri and Acar (2019), used 12 oats genotypes and defined crude protein content between 9.64-11.53%. Our results were similar to Çeri and Acar (2019), Koçer and Albayrak (2012) and Mut et al. (2015) studies.

Data related to DMD, DM and RFV values of genotypes are given (Table 6). While the DMD values of genotypes were 2.0-2.4% in the first year, and 2.1-2.3% in the second year, there was no difference between the genotypes considering the years. DM values of genotypes varied between 54.6-60.8% in the first year and 55.1-59.9% in the second year. While there were differences between genotypes in terms of DM, there was no difference between years. Koçer and Albayrak (2012) reported similar results in their study.

The relative feed value (RFV), which is included in different quality indices for the determination of forage quality, is based on the ADF and NDF contents. RFV in feed is of great importance in determining the quality and marketing of feeds. High RFV value indicates that the quality of forage is good. RFV values of genotypes ranged from 86.1-108.3% in the first year and 89.2-107.4% in the second year. G8 showed the highest quality in the first year because had 108.3% RFV followed by G5 with 107.7%, G11 with 105.9%, G9 with 102.0% and G2 variety with 100.9% RFV. In the second year, G8 with 107.4% RFV reached the highest quality feed value, followed by G5 with 103.2 %, G3 with 102.4% and G15 with 101.8% RFV. According to the two-year RFV average value G8, G5, G11 and G3 had the highest forage quality, while G10, G1, G4 and G6 genotypes had the lowest.

Koçer and Albayrak (2012), investigated feed peas mixtures with oat and barley, and reported 97.45% RFV for monoculture oat and 167.27% RFV for monoculture feed peas. As the feed pea ratio increased, the relative feed value of the feed increased. Koçer and Albayrak's (2012) results were similar to our results. Conslusion to the two-year results of our study, G6 (15.18 t ha^{-1}), G4 (14.63 t ha^{-1}), G13 (14.15 t ha^{-1}) and G2 (13.82 t ha^{-1}) genotypes had the highest hay yield. The G8 (107.8%), G5 (105.5%), G11 (102.9%) and G3 (101.3%) showed highest RFV and forage quality. G2, G9 and G8 were suitable in terms of hay yield and RFV for Trakya-Marmara region. Besides, G2 and G9 with high forage quality and hay yield and early flowering characteristics are recommended for the second crop planting places.

Author's Contributions

The contribution of the authors is equal

Statement of Conflict of Interest

Authors have declared no conflict of interest

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