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Determination of High Yield and Quality Sainfoin Genotypes (*Onobrychis viciifolia* Scop.) for the Bingöl Province of Turkey

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ABSTRACT

This research was carried out for two years between 2017-2018 to determine the high yield and quality sainfoin genotypes for Bingöl Province. A total of 13 genotypes were used as plant materials, two of which were registered cultivars (Lutfibey, Peschanyj 1251), six candidate cultivars (Emre, Hilal, Fatih, Mehmetalibey, Koc 1461, Yunus) and five were populations (Genc, Adakli, Yedisu, Ankara, Tarim). In the study forage yields, dry matter yields, crude protein ratios, crude protein yields, ADF (acid detergent fiber) ratios, NDF (neutral detergent fiber) ratios, digestible dry matter ratios and relative feed values of genotypes were investigated. As the average of two years of the genotypes; the forage yield was 1832±60 kg da^{-1}, the dry matter yield was 576±20 kg da^{-1}, the crude protein rate was 16.4±0.3%, the crude protein yield was 95.3±3.9 kg da^{-1}, the ADF rate was 31.2±0.5%, the NDF rate was 43.8±0.6%, the digestible dry matter rate was 64.6±0.4% and the relative feed value was obtained as 139±2.3. According to two years data in the study, the differences between genotypes were found statistically significant ($p<0.01$) in terms of forage yield, dry matter yield and crude protein yield, but the differences between genotypes were found to be statistically insignificant in terms of crude protein, ADF, NDF and digestible dry matter ratios and relative feed value. As a result, it was determined that Tarim, Hilal, Peschanyj and Lutfibey genotypes came to the fore in the conditions of Bingöl Province in terms of the examined characteristics.

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Bingöl İli İçin Yüksek Verim ve Kaliteye Sahip Korunga Genotiplerinin (*Onobrychis viciifolia* Scop.) Belirlenmesi

ÖZET

Bu araştırma, Bingöl ili için verim ve kalitesi yüksek korunga genotiplerini belirlemek amacıyla 2017-2018 yılları arasında iki yıl süreyle yürütülmüştür. Araştırmada iki adet tescilli çeşit (Lütfibey, Peschanyj 1251), altı adet çeşit adayı (Emre, Hilal, Faith, Mehmetalibey, Koç 1461) ve beş adet populasyon (Genç, Adaklı, Yedisu, Ankara ve Tarım) olmak üzere toplam 13 adet genotip bitkisel materyal olarak kullanılmıştır. Araştırmada genotiplerin yeşil ot verimleri, kuru ot verimleri, ham protein oranları, ham protein verimleri, ADF (asit deterjanda çözünmeyen lif) oranları, NDF (nötral deterjanda çözünmeyen lif) oranları, sindirilebilir kuru madde oranları ve nispi yem değerleri incelenmiştir. Genotiplerin iki yıllık ortalaması olarak yeşil ot verimi 1832±60 kg/da, kuru ot verimi 576±20 kg/da, ham protein oranı %16.4±0.3, ham protein verimi 95.3±3.9 kg/da, ADF oranı %31.2±0.5, NDF oranı %43.8±0.6, sindirilebilir kuru madde oranı %64.6±0.4 ve nispi yem değeri 139±2.3 olarak elde edilmiştir. Iki yıllık verilere göre araştırmada yeşil ot verimi, kuru ot verimi ve ham protein verimi açısından genotipler arasında tespit edilen farklılıkların istatistiksel olarak önemli ($p<0.01$), ham protein, ADF, NDF ve sindirilebilir kuru madde oranları ile nispi yem değeri açısından ise genotipler arasında tespit edilen farklılıkların istatistiksel olarak önemsiz olduğu

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belirlenmiştir. Sonuç olarak incelenen özellikler açısından Tarım, Hilal, Peschanyj ve Lütfibey genotiplerinin Bingöl ili koşullarında ön plana çıktığı belirlenmiştir.

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INTRODUCTION

There are 80-100 species in the sainfoin genus. The most cultivated species of this genus is *Onobrychis viciifolia* Scop. Sainfoin is a short-lived perennial forage plant. It is cultivated as forage plant, soil conservation plant and nectar-pollen plant. Since it is resistant to grazing, it is a good pasture plant as well as a good rotation plant in arid regions. The forage quality is good and the dry matter contains about 17% crude protein. In addition, it is rich in calcium, phosphorus and other elements (Ekiz et al., 2011).

Sainfoin is resistant to cold and drought. It can grow in poor and calcareous soils where alfalfa cannot grow. However, it cannot compete with alfalfa in terms of yield under irrigation. Sainfoin forage does not cause bloating in animals, as does alfalfa. Therefore, its forage can be given to animals as much as desired (Soya et al., 2004).

Sainfoin gives one harvest every year in drought conditions. In such conditions, 1 000 kg da^{-1} forage and an average of 250-300 kg da^{-1} dry matter yields were recorded from sainfoin cultivation. Dry matter yield in humid areas and irrigated fields can range between 500 and 1000 kg da^{-1}. Sainfoin lives an average of 3-4 years and gives the highest yield in the second and third years. It becomes sparse in the fourth year. Therefore, at the end of the third year, another plant should be grown instead of sainfoin (Acikgoz, 2001; Acikgoz, 2013).

According to data from the Turkish Statistical Institute, in 2021, 1.546.641 tons of forage was produced on a 1.814.737 da area of sainfoin. Forage yield per decare was 887 kg. In the province of Bingol, where the research was conducted, it was recorded that the yield per decare was 1.598 kg (TUIK, 2022).

Many studies on sainfoin have been carried out in Turkey. Turk and Celik (2005) studied, the effect of row spacing and seed quantities on the yield of sainfoin; Erkovan and Tan (2009) investigated, determination of some properties of forage and seed yield in the sainfoin cultivars grown in irrigated and arid conditions; Elmali Aksu and Kaya (2012) found, the effect of different harvest times on the nutrient content of sainfoin; Ertus et al. (2012) studied, determination of some features of local sainfoin varieties grown around Van Province; Parlak Ozaslan et al. (2014) examined, morphological and agronomic features of some wild sainfoin species; Cecen et al. (2015) investigated, morphological characteristics of sainfoin populations that the collected in the natural flora of Antalya and Koc and Akdeniz (2017) determined, the yield and some agricultural characteristics of the sainfoin varieties developed in State Farm Gozlu and Altınova. These studies have been carried out for different purposes, at different times and in different regions. However, as can be seen from those studies and from the review of literature, focus on forage quality and digestibility of sainfoin are limited and inadequate.

This study was carried out to determine the sainfoin genotypes with high yield, quality, digestibility and relative feed value for the Province of Bingöl.

MATERIAL and METHOD

Experimental materials

In this study, a total of 13 genotypes (2 registered cultivars, 6 cultivar candidates and 5 populations), obtained from some institutions and organizations were used as plant materials. The names types (cultivar, cultivar candidate and population) and sources of the genotypes were presented in Table 1.

Research area

This research was carried out on the Field Research and Application Center of the Bingol University, Genc Vocational School. Bingol is located in Eastern Anatolia Region, Turkey. The district of Genc, where the research was conducted, is 20 km from Bingol city center and its height from the sea level is 986 m on average. The research area is located on the coordinates of 38.749450 North latitude and 40.536770 East longitude.

Climate data of the research area

An analysis of the provincial climate data, obtained from the Bingol Provincial Meteorology Directorate, shows that, the average temperature of the province over a long time (2000-2015) was on average of 12.3 ^{0}C, precipitation being 917.8 mm and humidity rate at 56.6%. July and August are the months when the temperature is the highest with the lowest amount of precipitation and humidity. It was recorded that most of the precipitation falls in the winter months and the lowest temperature and the highest humidity values are obtained during these months. The years 2017 and 2018 were hot and less rainy compared to long years (Table 2).

Table 1. Genotypes used as research materials and sources from which genotypes were provided
Çizelge 1. Araştırma materyali olarak kullanılan genotipler ve temin edildikleri kaynaklar

1	Lutfibey	Cultivar	East Anatolian Agricultural Research Institute
2	Peschanyj 1251	Cultivar	Maro Agriculture Company
3	Emre	Cultivar candidate	General Directorate of Agricultural Enterprises
4	Hilal	Cultivar candidate	General Directorate of Agricultural Enterprises
5	Fatih	Cultivar candidate	General Directorate of Agricultural Enterprises
6	Mehmetalibey	Cultivar candidate	General Directorate of Agricultural Enterprises
7	Koc 1461	Cultivar candidate	General Directorate of Agricultural Enterprises
8	Yunus	Cultivar candidate	General Directorate of Agricultural Enterprises
9	Genc	Population	Genc District of Bingol Province
10	Adakli	Population	Adakli District of Bingol Province
11	Yedisu	Population	Yedisu District of Bingol Province
12	Ankara	Population	Ankara Province
13	Tarim	Population	Agriculture Directorate of Bingol Province

Table 2. Monthly average climate data of Bingöl for 2017-2018 and long years (2000-2015)*
*Çizelge 2. Bingöl ilinin 2017-2018 ve uzun yıllara (2000-2015) ait aylık ortalama iklim verileri**

Months *Aylar*	Average temperature (°C) *Ortalama sıcaklık (°C)*			Total precipitation (mm) *Toplam yağış (mm)*			Relative humidity (%) *Nispi nem (%)*		
	2017	2018	Long years	2017	2018	Long years	2017	2018	Long years
January	-3.7	2.0	-2.5	63.9	204.0	154.0	71.1	72.7	73.3
February	-2.3	5.2	-0.9	32.9	74.9	137.7	61.6	65.8	72.2
March	5.9	10.3	4.9	114.5	72.2	124.1	64.7	59.1	64.2
April	10.8	14.4	10.9	166.4	57.1	103.8	58.8	44.1	61.2
May	16.4	16.4	16.2	92.4	163.0	66.8	56.2	67.9	55.8
June	22.6	22.6	22.6	9.6	33.3	18.4	39.0	47.4	42.5
July	28.0	27.1	27.0	0	4.6	7.3	28.1	30.6	36.7
August	27.6	27.4	26.8	2.5	11.7	5.4	26.0	31.1	36.8
September	23.5	22.6	21.3	0	11.7	16.4	26.4	37.0	42.2
October	13.4	15.9	14.2	52.8	104.5	70.3	48.6	55.6	58.9
November	7.3	7.9	6.5	99.5	83.6	91.8	68.5	72.4	64.7
December	3.7	3.2	0.2	74.6	84.4	121.8	69.8	65.4	70.7
Total/Ave.	12.8	14.6	12.3	709.1	905.0	917.8	51.6	54.1	56.6

*(Anonymous, 2019)

Soil properties of the research area

Soil analyses of the research area were carried out at the Bingol University Faculty of Agriculture. The results of the analysis were evaluated on the basis of limit values as described by Sezen (1995) and Zengin (2012). Accordingly, the soil structure was sandy-clayey-loamy structure (60% sand, 18% clay, 22% loam), pH was neutral (7.26), less lime (3.48%), unsalted (0.34 mS cm^{-1}), organic matter ratio was on medium level (2.1%), phosphorus (5.1 kg da^{-1}) and potassium (43.6 kg da^{-1}) rates were also found to be low.

Experimental methods

Since the sainfoin plant did not develop much in the first planting year in dry conditions, forage and seed production data were not taken. Plants begin to develop rapidly in the spring of the second year as explained by Acikgoz (2001). In this study, sowing was made on 06.04.2016. However, as stated by Acikgoz (2001), no yields were made in 2016. In order to combat weeds, herbage cleaning was done twice. The harvest was made on 29.05.2017 in the second year and on 27.05.2018 in the third year. Therefore, although this study was carried out in three consecutive years as

2016, 2017 and 2018, only 2017 and 2018 data were evaluated.

In the study, the parcel lengths were 5 m, distances between rows were 30 cm and each plot had 6 rows. 10 kg seeds were used per decare. During sowing, 4 kg da^{-1} nitrogen and 10 kg da^{-1} phosphorus fertilizers were applied (Tan & Sancak, 2009).

Considering the side effects, 50 cm parts of the upper and lower parts of the side rows and plots were removed from the harvest. Forage yield was calculated by weighing the herbage cut from each parcel and transforming it into yield per decare. Five hundred grams of forage taken from each parcel was dried at 70 ^{0}C for 48 hours, and dry matter yield was calculated from the result obtained (Anonymous, 2020). Crude protein, ADF (Acid detergent fiber) and NDF (Neutral detergent fiber) ratios were determined with the help of Near Infrared Spectroscopy (NIRS) device. This method was used by many researchers including Basaran et al. (2011) and Cinar and Hatipoglu (2015).

Crude protein yield was obtained by multiplying the dry matter yield by the crude protein ratio (Basbag et al., 2015), and the DDM (Digestible dry matter) ratio and RFV (Relative feed value) with the help of ADF and NDF ratios (Van Dyke & Anderson, 2000; Morrison, 2003).

Statistical model

The study was set up with three replications according to the random block trial design. ANOVA was used to obtain data by JMP statistics program. The averages of the groups were compared with the Tukey test according to the %5 significance level (JMP, 2018).

RESULTS and DISCUSSION

Forage and dry matter yields (kg da^{-1})

Forage and dry matter yields of sainfoin genotypes were presented in Table 3. Genotype, year and year x genotype interactions were found statistically significant in terms of forage and dry matter yield.

Table 3. Forage yield and dry matter yield of sainfoin genotypes
Çizelge 3. Korunga genotiplerinin yeşil ot ve kuru ot verimleri

Genotypes *Genotipler*	Forage yield (kg da^{-1}) *Yeşil ot verimi (kg da^{-1})*			Dry matter yield (kg da^{-1}) *Kuru ot verimi (kg da^{-1})*		
	2017	2018	Mean	2017	2018	Mean
Adakli	1363±112 f-k	984±66 kl	1173±102 GH	453±25 g-l	295±22 lm	374±38 DE
Ankara	2250±48 a-d	1784±128 d-g	2017±120 CD	728±29 a-c	486±26 e-l	607±57 BC
Emre	2552±167 a	1530±68 e-j	2041±242 B-D	824±42 a	480±27 f-l	652±80 BC
Fatih	2250±189 a-d	1326±128 g-k	1788±230 DE	761±103 ab	441±39 h-l	601±87 BC
Genc	1272±41 i-l	824±55 l	1048±104 H	385±5 i-m	218±15 m	302±38 E
Hilal	2248±55 a-d	1893±64 b-e	2071±87 B-D	774±52 ab	660±17 a-f	717±35 AB
Koc 1461	1837±121 c-f	1763±65 e-h	1800±63 DE	596±15 b-h	541±32 c-j	569±20 C
Lutfibey	1711±107 e-i	2600±128 a	2156±212 A-C	680±42 a-e	649±27 a-g	665±24A-C
Mehmetalibey	2337±65 ab	1539±66 e-j	1938±183 CD	672±51 a-f	579±15 b-i	625±32 BC
Peschanyj 1251	2344±121 ab	2305±70 a-c	2325±63 AB	756±17 ab	692±33 a-d	724±22 AB
Tarim	2614±94 a	2302±71 a-c	2458±87 A	830±55 a	744±21 ab	787±33 A
Yedisu	1296±32 h-l	1877±65 b-e	1587±133 EF	357±4 j-m	495±23 d-k	426±33 DE
Yunus	1610±77 e-j	1209±65 j-l	1409±100 FG	538±43 c-j	332±17 k-m	435±50 D
Mean	1976±78 A	1687±84 B	1832±60	643±27 A	509±26 B	576±20
CV (%)		8.25			10.88	
Genotype (G)		**			**	
Years (Y)		**			**	
G x Y		**			**	

**: P≤0.01

From the two-year averages, the highest forage yield was obtained from the Tarim genotype with 2458 kg da^{-1}. Peschanyj-1251 (2325 kg da^{-1}) and Lutfibey (2156 kg da^{-1}) cultivars in the same group were next in terms of yield. The lowest forage yield was obtained from genotype from the Genc district with 1048 kg da^{-1}. In terms of years, it was seen that 2017 (1976 kg^{-1}) yielded a higher forage yield than 2018 (1687 kg^{-1}). The two-year forage yield average obtained was 1832 kg da^{-1} as presented in (Table 3).

According to the two-year average, the highest dry matter yield was obtained from the Tarim genotype with 787 kg da^{-1}. Peschanyj-1251 (724 kg da^{-1}), Hilal (717 kg da^{-1}) and Lutfibey (665 kg da^{-1}) cultivars in the same group followed this observation statistically. The lowest dry matter yield was obtained from the genotype obtained from Genc district with 302 kg da^{-1}. It was seen that 2017 (643 kg da^{-1}) yields a higher dry matter than 2018 (509 kg da^{-1}). The two-year dry matter yield determined was 576 kg da^{-1} as presented in (Table 3).

The average forage yield was 1832 kg da^{-1} and dry matter yield was 576 kg da-1. It was observed that Tarım, Peschanyj-1251, Mehmetalibey, Lutfibey, Hilal, Emre and Ankara genotypes gave forage and dry matter yields above the average (Figure 1).

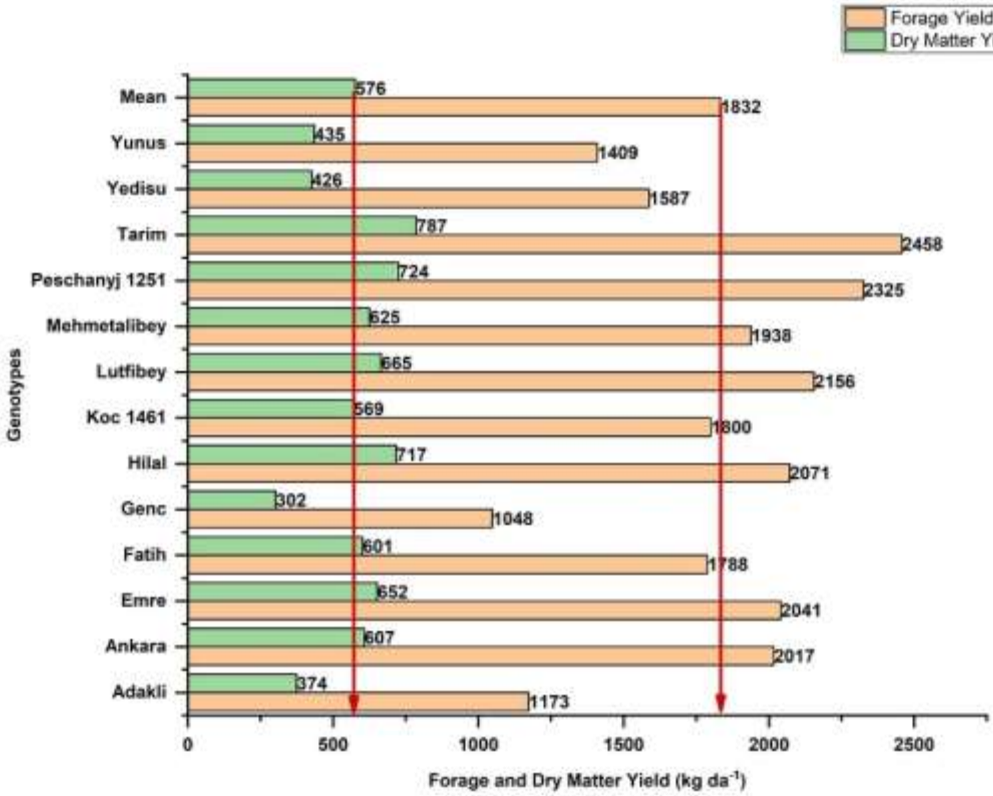

Figure 1. Forage and Dry Matter Yield of Sainfoin Genotypes
Şekil 1. Korunga genotiplerinin yeşil ve kuru ot verimleri

Erkovan and Tan (2009) reported a dry matter yield of 1016 kg da-1, 776 kg da-1, 749 kg da-1 and 410 kg da-1 over a period of four years, in irrigated and arid conditions, respectively. The differences between the yield values obtained may be attributed to the ecological conditions and genotypes used. However, in the four-year study, dry matter yields decreased systematically every year and this decrease was found to be statistically significant. This situation was similar to the decrease in both forage and dry matter yield values obtained in the second year in this study. Acikgoz (2001) reported that the sainfoin yielded the highest yield in the second and third years and the field should be plowed in the fourth year. In this study, since the first year was the year of establishment, the data obtained were not evaluated. The highest yield values were obtained in the second year (in 2017). Yield values decreased during the third year (2018) and the study was concluded in the fourth year.

Unal and Firincioglu (2007) found that there were significant differences between the years in the study they carried out with three genotypes under the conditions of the Central Anatolian region. They reported a forage yield of 2121 kg da-1 in the first year, 307 kg da-1 in the second year resulting in an average of 1214 kg da-1. They also reported a dry matter yield of 564 kg da-1 in the first-year, 104 kg da-1 in second-year thus averaging in 334 kg da-1.

Crude protein ratio (CP) (%) and crude protein yield (CPY) (kg da-1)

Genotype, year and genotype x year interaction were found insignificant in terms of crude protein ratio of sainfoin genotypes. The crude protein ratio of genotypes varied between 14.2% and 17.7%, with an average of 16.4%. The crude protein rate was 16.8% in 2017 and the crude protein rate was 16.1% in 2018 (Table 4).

Genotype, year and genotype x year interaction were found statistically significant in terms of crude protein yield. When the genotypes were compared, it was observed that the highest crude protein yield was obtained from the Tarim population (133.0 kg da-1), followed by the Emre (112.9 kg da-1) and Hilal (122.3 kg da-1) cultivars. It was observed that the populations obtained from Adakli and Genc districts, recorded the lowest crude protein yields. The crude protein yield (108.1 kg da-1) obtained in 2017 was higher than the crude protein yield (82.5 kg da-1) obtained in 2018 (Table 4).

Table 4. Crude protein ratio and crude protein yield of sainfoin genotypes
Çizelge 4. Korunga genotiplerinin ham protein oranları ve ham protein verimleri

Genotypes *Genotipler*	Crude protein ratio (%) *Ham protein oranı (%)*			Crude protein yield (kg da^{-1}) *Ham protein verimi (kg da^{-1})*		
	2017	2018	Mean	2017	2018	Mean
Adakli	16.5±2.6	14.7±0.1	15.6±1.2	73.4±7.1 d-g	43.4±3.0 fg	58.4±7.5 D
Ankara	16.0±1.7	17.6±0.4	16.8±0.8	117.4±16.9 a-d	85.9±6.3 c-g	101.7±10.7 A-C
Emre	18.1±1.8	15.7±0.8	16.9±1.0	150.6±22.8 a	75.2±1.4 c-g	112.9±19.7 A
Fatih	17.5±1.1	16.9±0.4	17.2±0.5	133.3±18.5 a-c	74.8±7.2 c-g	104.1±15.8 A-C
Genc	13.3±1.3	15.1±0.3	14.2±0.7	51.5±5.7 fg	33.1±2.5 g	42.3±4.9 D
Hilal	17.1±2.1	16.9±0.3	17.0±0.9	133.2±20.9 a-c	111.5±4.2 a-e	122.3±10.7 A
Koc 1461	17.0±1.9	17.3±1.7	17.1±0.9	101.4±12.0 a-f	94.2±11.0 a-f	97.8±7.4 A-C
Lutfibey	17.9±0.8	15.2±2.0	16.6±1.1	121.6±4.6 a-d	98.9±15.8 a-f	110.2±8.9 AB
Mehmetalibey	17.9±0.3	15.8±0.9	16.8±0.6	120.7±11.3 a-d	91.4±7.2 b-g	106.0±8.9 A-C
Peschanyj 1251	12.7±0.1	16.0±0.1	14.3±0.7	95.8±3.0 a-f	111.0±6.4 a-e	103.4±4.6 A-C
Tarim	17.5±0.6	16.1±0.5	16.8±0.4	145.8±14.7 ab	120.3±7.2 a-d	133.0±9.3 A
Yedisu	19.3±1.2	16.1±0.2	17.7±0.9	68.9±5.2 d-g	79.5±4.6 c-g	74.2 ±3.9 B-D
Yunus	17.3±1.1	15.9±0.7	16.6±0.6	92.3±4.5 a-f	52.8±3.3 e-g	72.5±9.1 D
Mean	16.8±0.4	16.1±0.2	16.4±0.3	108.1±5.6 A	82.5±4.4 B	95.3±3.9
CV (%)		12.62			19.47	
Genotype (G)		ns			**	
Years (Y)		ns			**	
G x Y		ns			**	

ns: Non significant. **: P≤0.01

Average crude protein yield obtained was 95.3 kg da^{-1}. It was determined that Tarim, Peschanyj-1251, Mehmetalibey, Lutfibey, Koc 1461, Hilal, Fatih Emre and Ankara genotypes gave crude protein yield above the average as presented on Figure 2.

In a study with sainfoin cultivars, Temel and Ozalp (2016) reported a crude protein rate (although varying according to altitude) of 16.0-17.0% in the 10% flowering period and Akdeniz (2019) reported a crude protein rate of 15.12-16.07%. These rates support the results obtained in this study. Ulger and Kaplan (2016) also reported a crude protein content in the flowering period of sainfoin populations ranging between 12.7% and 15.9%, with an observation that, the crude protein ratio was higher in registered cultivars and relatively lower in population samples. However, the crude protein ratios recorded in this study did not differ between populations and registered cultivars. The crude protein ratio may differ depending on the genetic structure of the plant as well as the development stages of the plant. Therefore, the crude protein content may differ in different genotypes or in different harvesting periods.

Turk (2005) reported a crude protein yield ranging between 57.0 and 122.3 kg da^{-1} in a three-year study conducted in order to determine the effect of different seed amounts and row spacing of sainfoin on crude protein yield. Akdeniz (2019) reported a crude protein yield of 100 kg da^{-1} as a result of a two-year study that examined the yield and quality characteristics of different cultivation methods and mixtures. These values were in consonance with the findings of this research.

Acid detergent fiber (ADF) (%) and neutral detergent fiber (NDF) (%)

Genotype and year x genotype interactions were not found statistically significant in terms of ADF and NDF ratios of sainfoin genotypes. Only the difference between years was found statistically significant (Table 5).

ADF ratios varied between 30.1% and 34.2% with the average of 31.2%, NDF ratios varied between 42.9% and 45.1% with the average of 43.8%. ADF (33.8%) and NDF (46.6%) ratios of 2018 were higher than ADF (28.6%) and NDF (41.4%) ratios of 2017 (Table 5).

The reason why the ADF and NDF ratios obtained in the second year were higher than the ADF and NDF ratios in the first year could be attributed to the aging of the plant. ADF and NDF ratios, which make up the plant cell wall, increased as the plants age.

ADF rates (32.0-34.0%) and NDF rates (44.0-46.5%) obtained from sainfoins at different altitudes by Temel and Ozalp (2016) support the results of this study. However, ADF rates (32.01-41.79%) and NDF rates (42.57-53.89%) reported by Ulger and Kaplan (2016) and ADF rates (41.57%) and NDF rates (50.53%) reported by Yavuz and Karadag (2016) were higher than the results of this study.

Digestible dry matter (DDM) (%) and relative feed value (RFV)

As can be observed from the Table 6, the difference between genotype and year x genotype interaction was statistically insignificant, but the difference between years was found to be significant in terms of digestible dry matter and relative feed value of sainfoin genotypes.

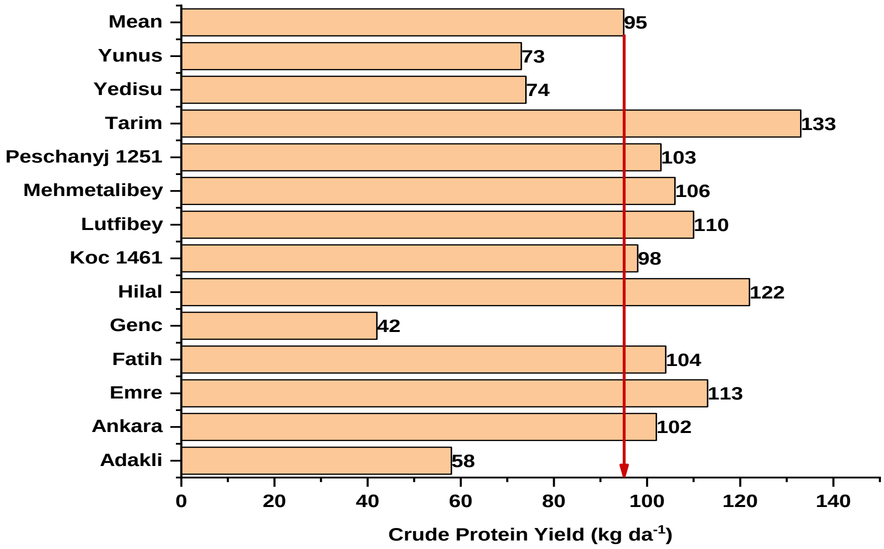

Figure 2. Crude Protein Yield of Sainfoin Genotypes
Şekil 2. Korunga genotiplerinin ham protein verimleri

Table 5. Acid detergent fiber and neutral detergent fiber of sainfoin genotypes
Çizelge 5. Korunga genotiplerinin asit ve nötral deterjanda çözünmeyen lif oranları

Genotypes *Genotipler*	ADF (%) *ADF (%)*			NDF (%) *NDF (%)*		
	2017	2018	Mean	2017	2018	Mean
Adakli	27.7±2.8	33.4±0.3	30.5±1.8	41.2±3.9	45.2±0.2	43.2±1.9
Ankara	26.9±3.1	35.3±0.6	31.1±2.3	39.1±2.8	48.6±0.9	43.8±2.4
Emre	29.0±4.3	32.4±1.6	30.7±2.2	41.4±4.8	43.7±1.6	42.5±2.3
Fatih	27.9±2.1	34.3±0.6	31.1±1.7	39.8±2.0	47.0±0.9	43.4±1.8
Genc	29.7±0.8	33.8±0.1	31.7±0.9	42.3±1.3	47.9±0.4	45.1±1.3
Hilal	28.6±5.5	34.2±0.9	31.4±2.7	39.9±6.1	47.3±0.9	43.6±3.2
Koc 1461	28.8±3.1	35.5±1.1	32.2±2.0	41.3±3.1	48.4±1.6	44.9±2.2
Lutfibey	28.8±1.8	31.3±1.9	30.1±1.3	41.7±2.6	44.2±2.9	42.9±1.8
Mehmetalibey	29.8±3.9	32.2±1.7	31.0±2.0	42.6±4.3	45.2±2.2	43.9±2.2
Peschanyj 1251	28.7±0.1	39.7±0.4	34.2±2.4	41.5±0.2	52.9±0.2	47.2±2.5
Tarim	29.6±0.5	32.2±0.9	30.9±0.7	41.2±0.7	44.7±1.0	43.0±0.9
Yedisu	28.4±1.1	32.2±0.9	30.3±1.0	41.6±1.3	44.6±0.9	43.1±0.9
Yunus	28.1±2.1	32.4±0.3	30.2±1.3	40.8±2.0	45.8±0.6	43.3±1.4
Mean	28.6±0.7 B	33.8±0.2 A	31.2±0.5	41.1±0.8 B	46.6±0.3 A	43.8±0.6
CV (%)		11.71			9.42	
Genotype (G)		ns			ns	
Years (Y)		**			**	
G x Y		ns			ns	

ns: Non significant. **: P≤0.01

The digestible dry matter ratios of the sainfoin genotypes varied between 63.9% and 65.5%, and the relative feed values varied between 126 and 145. Considering the average of the two years, the digestible dry matter ratio was 64.6% and the relative feed value was 139. The digestible dry matter ratio (66.6%) and relative feed value (151) obtained in 2017 were statistically higher than the values (62.6% and 127, respectively) obtained in 2018 (Table 6).

The reason why the genotypes have higher digestible dry matter ratio and relative feed values in 2017 compared to 2018 was due to the fact that the plant was younger in the first year compared to the second year. As the plants got older, the ADF and NDF ratios increased, while their digestibility and relative feed values decreased.

Yavuz and Karadag (2016) reported that the in vitro digestibility rate of sainfoin was 61.30% and Ulger and Kaplan (2016) reported that the organic matter digestion rate ranged between 60.7% and 72.59%. The results obtained from this study are in agreement with the results of the researchers.

Table 6. Digestible dry matter and relative feed value of sainfoin genotypes
Çizelge 6. Korunga genotiplerinin sindirilebilir kuru madde ve nispi yem değerleri

Genotypes *Genotipler*	Digestible dry matter (%) *Sindirilebilir kuru madde (%)*			Relative feed value *Nispi yem değeri*		
	2017	2018	Mean	2017	2018	Mean
Adakli	67.3±2.2	62.9±0.2	65.1±1.4	152±17.7	133±1.4	142±9.0
Ankara	68.0±2.4	61.4±0.4	64.7±1.8	162±11.7	119±4.6	140±11.1
Emre	66.3±3.4	63.7±1.2	65.0±1.7	150±20.7	140±8.7	145±10.2
Fatih	67.2±1.6	62.2±0.5	64.7±1.3	157±8.3	124±5.2	141±8.6
Genc	65.8±0.6	62.6±0.1	64.2±0.7	145±4.5	122±1.3	133±5.5
Hilal	66.6±4.2	62.3±0.7	64.4±2.1	155±22.8	129±5.2	142±12.0
Koc 1461	66.4±2.4	61.3±0.8	63.9±1.6	150±11.8	119±8.0	135±9.4
Lutfibey	66.5±1.4	64.5±1.5	65.5±1.0	150±10.3	137±14.9	144±8.6
Mehmetalibey	65.7±3.0	63.8±1.3	64.8±1.5	145±17.7	135±11.2	140±9.6
Peschanyj 1251	66.6±0.1	58.0±0.3	62.3±1.9	149±0.7	102±1.8	126±10.5
Tarim	65.8±0.4	63.8±0.7	64.8±0.5	149±3.1	133±5.1	141±4.5
Yedisu	66.7±0.8	63.8±0.7	65.3±0.8	149±5.7	133±5.2	141±5.0
Yunus	67.0±1.7	63.6±0.3	65.3±1.0	153±9.6	130±3.1	141±6.8
Mean	66.6±0.5 A	62.6±0.2 B	64.6±0.4	151±3.3 A	127±1.7 B	139±2.3
CV (%)		4.40			12.49	
Genotype (G)		ns			ns	
Years (Y)		**			**	
G x Y		ns			ns	

ns: Non significant. **: P≤0.01

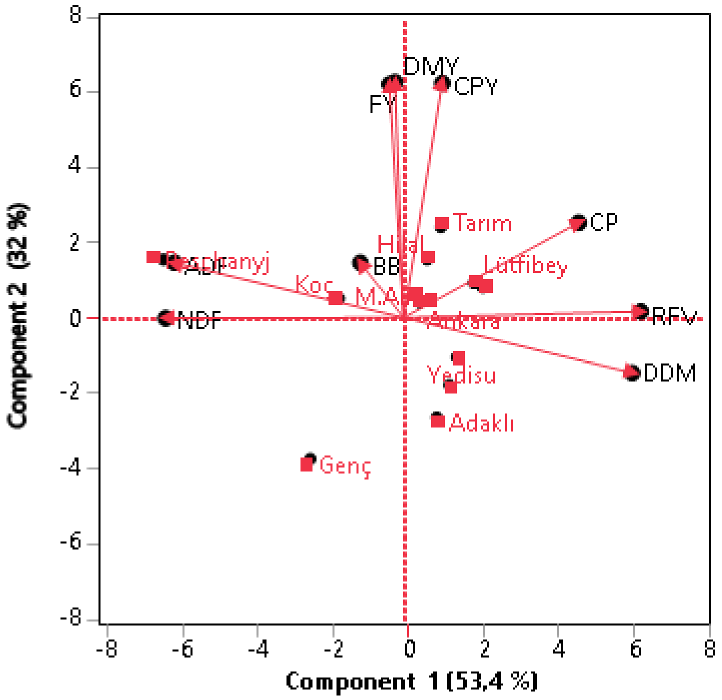

Figure 3. Biplot plot of the relationship between genotypes and traits studied
Şekil 3. Genotipler ile incelenen özellikler arasındaki ilişkinin biplot analizi

Examination of the relationship between genotypes and examined traits by Biplot analysis

The relationship between genotypes and the examined traits was presented on Figure 3. It can be observed that there is an interaction of 85.4%, with the first main component being 53.4% and the second main component being 32.0%, between the genotypes and the investigated features.

According to Basbag et al. (2018), if the angle between the features examined in the biplot analysis was less than 90⁰, there was a positive and significant relationship between them. From this point of view, it can be inferred that the examined features are divided into three groups. It can be observed that the forage yield, dry matter and crude protein yields formed a group, crude protein, digestible dry matter And relative feed value formed another group, and ADF and NDF ratios formed the third group. It was observed that there were statistical differences between the forage, dry matter and crude protein yields obtained from the genotypes considered in the study (Table 2, Table 3). As a result of the biplot analysis, it was observed that Tarim and Hilal cultivars were outstanding in terms of forage, dry matter and crude protein yields, which make up the first group and were statistically significant different from the other groups.

CONCLUSION

As a result of the two-year study, the highest results in terms of forage and dry matter yield were obtained from the Tarim population obtained from the Provincial Directorate of Agriculture. Along with this, population samples, Peschanyj and Lutfibey cultivars as well as Hilal, a registered cultivar were also determined to be the genotypes which gave the highest results. It has been observed that the Tarim population with the Emre and Hilal cultivars stands out in terms of crude protein yield. No statistically significant differences were found between genotypes in terms of crude protein ratio, ADF ratio, NDF ratio, digestibility dry matter and relative feed value. However, statistically significant increases in ADF and NDF ratios, and significant decreases in digestibility and relative feed values were detected in the second year. As the year progresses, it was observed that there was significant decrease in yield, quality, digestibility and relative feed values. In addition, as a result of the biplot analysis, it was observed that Tarım population and Hilal cultivars stand out in terms of forage, dry matter and crude protein yields. As a results; Tarim, Hilal, Peschanyj and Lutfibey genotypes came to the fore in terms of the examined characteristics and these genotypes were recommended for the Bingöl Province.

Researchers' Contribution Rate Statement

The authors declare that they have contributed equally to the article.

Conflict of Interest Statement

The article authors declare that they do not have any conflict of interest.

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