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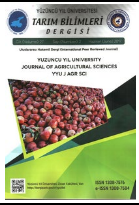

Araştırma Makalesi (Research Article)

The Variation for Dry Weight and Hay Quality in Turkish Origin Wild Chicory (*Cichorium intybus* L.) Genotypes

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Abstract: This study was conducted to determine dry plant weight and quality traits of chicory (*Cichorium intybus* L.) genotypes collected from eight provinces and 29 locations in Turkey. Field experiment was conducted in Yozgat conditions for two years (2015-2016 and 2016-2017) and the observations were performed in the second year. Dry plant weight, crude protein ratio and protein yield (g plant^{-1}), ADF, NDF, K, P, Ca, Mg contents and K/(Ca+Mg) and Ca/P ratio were determined in chicory genotypes as yearly total or average. Total dry plant weight and average crude protein content ranged between 167.80-564.60 g plant^{-1} and 11.85-16.60%, respectively. The highest potassium content was determined as 2.442%, while it was lowest as 2.022%. The phosphorus, calcium and magnesium content ranged between 0.367-0.413%, 0.963-1.232% and 0.250-0.407%, respectively. As a result, significant differences were observed among the chicory genotypes for all the traits. Such a variation even in the restricted area is point out the high variation in Turkey. These differences encouraged to new studies on chicory in Turkey and were also promising for improving new varieties.

Ot Verimi ve Kalitesi Bakımından Türkiye Orjinli Yabani Hindiba (*Cichorium intybus* L.) Genotiplerinin Çeşitliliği

Makale Bilgileri

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Anahtar kelimeler
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Öz: Bu çalışma, Türkiye genelinde sekiz il ve 29 farklı lokasyondan toplanan yabani hindiba (*Cichorium intybus* L.) genotiplerinin bitki başına kuru ot verimi ve kalite özelliklerini belirlenmek amacıyla yürütülmüştür. Tarla çalışması Yozgat koşullarında ve iki yıl (2015-2016 ve 2016-2017) süreyle yürütülmüş, gözlemler ikinci yılda alınmıştır. Çalışmada, yıllık ortalama veya toplam değer olarak, verim (g/bitki) protein oranı (%) ve verimi (g/bitki), ADF, NDF, K, P, Ca, Mg içeriği (%) ile K / (Ca+Mg) ve Ca/P oranları belirlenmiştir. Toplam kuru bitki ağırlığı ve ham protein içeriği, sırasıyla 167.80-564.60 g/bitki ve % 11.85-16.60 arasında değişmiştir. Genotipler arasında potasyum içeriği en yüksek % 2.442 ve en düşük % 2.022 olarak tespit edilmiştir. Fosfor, kalsiyum ve magnezyum içeriği ise sırasıyla % 0.367-0.413, % 0.963-1.232 ve % 0.250-0.407 arasında değişmiştir. Sonuç olarak incelen tüm özellikler bakımından genotipler arasında önemli farklılıklar olduğu belirlenmiştir. Kısıtlı bir coğrafyadan toplanılan genotiplerde belirlenen bu düzeydeki farklılık Türkiye genelinde çok daha yüksek bir çeşitliliğin olacağına işaret etmektedir. Bu çeşitlilik Türkiye'de hindiba konusunda yeni çalışmaları teşvik etmektedir ve yem bitkisi amaçlı yeni hindiba çeşitlerin geliştirilmesi adına ümit vericidir.

1. Introduction

Chicory (*Cichorium intybus* L.) "yabani hindiba in Turkish", is a perennial herb of the *Asteraceae* family has been cultivated different purposes such as forage, leaf vegetable, coffee additive and inulin source, a type of prebiotic fiber, in different countries for over three centuries (Munoz, 2004). The chicory which was an original component of natural pastures was later used in the artificial pastures of the Mediterranean climate due to its high forage potential (Molle et al., 2008). Chicory is widely distributed in Africa, Asia, Europe, Australia, Northern America and Southern America (Nieddu et al., 1999). Although it has a long history in agriculture, its use as a modern forage crop for livestock especially in grazing dates back to the last decades (Piluzza et al., 2014). The studies to improve forage varieties began in New Zealand in the 1980's and, the first varieties "Grasslands Puna" were registered in this country (Rumball, 1986).

Chicory is extremely tolerant to the high temperature and drought due to its rosette growth habit, deep and large root system, therefore, it can stay green during the summer period, when many of the forages are dormant or dry (Kiers et al., 1999). Chicory is mineral rich forage, similar to alfalfa and higher than grasses (Scales et al., 1994), and has a high palatable for ruminants but low in fiber (Athanasiadou et al., 2007). High feed quality and low Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) content of chicory would provide more energy and support high live weight gain and milk yield (Moloney and Milne, 1993; Di Grigoli et al., 2012). However, grown a mixture with other forages can be best use to eliminate the negative effects of low fiber concentration (Holden et al., 2000). It was reported that chicory includes phytochemicals which positively support animal healthy by affecting the internal parasites in lambs, decreasing the methane production and increasing the reproductive rate in sheep (Nwafor et al., 2017).

Although chicory is naturally abundant in pastures, there is no study about forage yield, feed values and cultivation possibilities of this plant in Turkey. Chicory can make an important contribution to improving the lower yield and quality of pasture during the summer season, which is one of the biggest problems of animal production in Turkey. Therefore, the aim of this study was to determined dry plant weight and quality traits of wild genotypes of chicory collected from 29 different locations in Turkey.

2. Materials and Methods

Twenty-nine Turkish origin wild genotypes of chicory (*Cichorium intybus* L.) were investigated for hay yield and some quality traits in the experimental field of Agriculture Faculty of Yozgat Bozok University during 2014 and 2015 located in Yerkoy-Yozgat. The genotypes were collected from 7 provinces of Turkey with different numbers; Yozgat (21), Samsun (1), Amasya (1), Antalya (1), Nevsehir (1), Konya (3) and Kırsehir (1) (Table 1).

After cleaning the collected seeds were sown in peat media and, then seedling transplanted to the field with 50x50 distances. Ten plants were transferred to field for each population. The field experiment was established in May 2014 and, the data was collected in the second year on five plants for each genotype.

Soil properties of the experimental area were clay–loam with pH of 8.12 and 7.99% $CaCO_3$, 8.12 kg ha^{-1} phosphorus and 1.78% organic matter at the depth of 30 cm. Table 2 shows some meteorological parameters of experimental areas in 2015 and 2016, including monthly average temperature, monthly total precipitation, and relative humidity. Total precipitation of the long-term is 574.4 mm. it was 589.2 mm in 2014 and 481.4 mm in 2015.

Plants were harvested at three times when they reached about 30.5 to 45.7 cm in height (Anonymous, 2019). Harvested plant samples were dried at 65 ^{0}C until they have a constant weight to determine dry plant weight (DPW). Crude protein content (CP), Acid detergent fiber (ADF), Neutral detergent fiber (NDF), Potassium (K), Phosphorus (P), Calcium (Ca), Magnesium (Mg) contents of hay were determined by using Near Infrared Reflectance Spectroscopy (NIRS, 'Foss 6500') with software package program "IC-0904FE". The total dry plant weight and total protein yield were calculated by using the total values of 3 harvesting times, while the crude protein content, ADF, NDF and mineral contents were calculated by using the average values of 3 harvesting times.

Data were statistically analyzed by repeated measure analysis in SPSS version 16.0 and means were grouped with Duncan's multiple-range test. The cluster analysis was carried out using the statistical software package PASW (16) Statistics Data Editor Program and the principal component analysis was carried out using the Multivariate Analysis using Biplots programs.

Table 1. The collection sites and coordinates of chicory genotypes

Code	Collection site	Coordinates	
Ams	Amasya-Merzifon	40° 52′ 06.65″ N	35° 28′ 46.51″ E
Ant	Antalya-Akseki	37° 02' 11.43"N	31° 46' 50.60"E
Kır	Kırsehir-Kaman	39° 21′ 24.93″ N	33° 41′ 51.41″ E
K-k	Konya-Kulu	39° 05′ 20.98″ N,	33° 02′ 40.04″ E
K-m	Konya-Meram	37° 40' 24.89"N	32° 28' 08.23"E
K-t	Konya-Tuzgolu	38° 45′.58"N	33° 21′ 22"E
Nev	Nevşehir-Avanos	38° 42′ 33.81″ N	34° 50′ 50.54″ E
Sam	Samsun-Merkez	41° 50′ 27.39″ N	36° 06′ 43.98″ E
Y-b1	Yozgat-Bogazlıyan 1	39° 24′ 20″ N	35° 00′ 27″ E
Y-b2	Yozgat-Bogazlıyan 2	39° 8′ 19.30"N	35° 22′ 41.22"E
Y-b3	Yozgat- Bogazlıyan 3	39° 19′ 55″ N	35° 08′ 35″ E
Y-c1	Yozgat-Candır 1	39° 14′ 36.15″ N	35° 31′ 01.91″ E
Y-c2	Yozgat-Candır 2	39° 14′ 47.68″ N	35° 32′ 07.00″ E
Y-k	Yozgat-Kadışehri	39° 57′ 22.28 N	35° 39′ 52.68″ E
Y-m1	Yozgat-Merkez 1	39° 50′ 24.89″ N	34° 51′ 58.77″ E
Y-m2	Yozgat-Merkez 2	39° 49′ 54.33″ N	34° 48′ 32.43″ E
Y-m3	Yozgat-Merkez 3	39°.62′.75.12"N	34°.94′.05.97"E
Y-m4	Yozgat-Merkez 4	39° 48′ 16″ N	34° 48′ 40″E
Y-m5	Yozgat-Merkez 5	39° 49′ 26.25″ N	34° 51′ 58.77″ E
Y-m6	Yozgat-Merkez, 6	39° 50′ 28.22″ N	34° 48′ 22.05″ E
Y-sr1	Yozgat-Sarıkaya 1	39° 32′ 22.12″ N	35° 15′ 15.70″ E
Y-sr2	Yozgat-Sarıkaya 2	39° 34′ 54.63″ N	35° 25′ 43.97″ E
Y-sr3	Yozgat-Sarıkaya 3	39° 33′ 34.57″ N	35° 23′ 11.62″ E
Y-so1	Yozgat-Sorgun 1	39° 54′ 08.78″ N	35° 02′ 12.17″ E
Y-so2	Yozgat-Sorgun 2	39° 50' 44.86"N	35° 65' 44.68"E
Y-y1	Yozgat-Yerkoy 1	39° 39′ 10.70"N	34° 29′ 15.13"E
Y-y2	Yozgat-Yerkoy 2	39° 38′ 53.82″ N	34° 33′ 14.20″ E
Y-y3	Yozgat-Yerkoy 3	39° 38′ 20.45″ N	34° 27′ 48.98″ E
Y-y4	Yozgat-Yerkoy 4	39° 40′ 57.65″ N	34° 35′ 25.75″ E

Table 2. Some meteorological parameters of experimental area in 2014 and 2015**

Months	Average temperature (^{O}C)			Total precipitation (mm)			Relative humidity (mm)		
	LTM*	2015	2016	LTM*	2015	2016	LTM*	2015	2016
January	-2.0	-1.0	-2.3	77.5	65.1	152.1	77.0	76.7	80.4
February	-0.9	0.8	4.6	75.8	61.5	50.4	74.9	73.3	73.1
March	3.0	4.4	5.4	71.0	62.1	48.6	70.0	69.5	63.1
April	8.3	6.1	12.0	66.6	69.5	14.8	66.6	61.9	49.8
May	12.9	14.1	12.6	64.2	62.1	69.3	64.0	59.9	67.5
June	16.8	16.0	18.4	60.5	42.2	26.2	60.3	71.5	58.9
July	19.8	19.8	20.4	56.8	14.8	0.5	56.6	54.7	53.0
August	19.7	21.5	21.8	55.7	9.9	2.2	55.4	54.0	55.8
September	15.6	19.6	15.4	58.1	19.0	11.5	57.8	49.6	56.6
October	10.2	11.6	11.0	65.9	42.6	2.6	65.9	71.7	58.3
November	4.2	5.8	5.0	72.5	63.8	34.9	72.1	62.6	54.8
December	0.0	-2.0	-3.3	77.3	76.6	68.3	76.8	80.2	78.9
Mean/Total	9.0	9.7	10.1	574.4	589.2	481.4	66.5	65.5	62.5

*LTM: Long term means; ** Turkish State Metrological Service

3. Results and Discussion

The dry plant yield of chicory genotypes as a total of three harvests was given in Table 3. The dry plant weight was significantly (p≤ 0.01) different between genotypes and it ranged from 167.80 (Y-m5) to 564.60 g/plant (K-m).

The ranking among cuttings for dry plant weight were as follows; first cutting > second cutting > third cutting (not provided in detail). This might be due to climatic condutions during to vegetation periods and re-growing potential of genotypes. The decrease in the dry plant weight is an expected situation for the plants because of the vegetation period decrease of other cutting compared to first cutting time. Sanderson et al. (2003) reported that the chicory is a long-day plant; therefore, it produces higher dry matter in first cutting than other cutting. In previous studies, range in dry plant weight in cichory was reported as 1372.9 – 3808.4 kg ha^{-1} (Sulas, 2004; Piluzza et al., 2014).

Statistically, differences between genotypes were found for crude protein content. End of the three cuttings, average crude protein content of total hay ranged from 11.85 (K-k) to 16.60% (Nev) among genotypes (Table 3). In all the genotypes, crude protein content was the highest in first cutting while it was lowest in the third cutting. Espinoza et al. (2016) reported that after first cutting, the chicory exhibited the very limited regrowth and, therefore the lower protein content. Previously, it was reported that crude protein content of chicory ranged between 16.20 and 20.07% (Piluzza et al., 2014; Espinoza et al., 2016). The total protein yield of chicory genotypes at the end of three harvests was given in Table 3. The protein yield was significantly (p≤ 0.01) different between genotypes with the range from 21.07 (Y-m5) to 88.13 g (K-m). Differences of genotypes in terms of crude protein content resulted from due to the combined effect of dry plant weight and crude protein content. Piluzza et al. (2014) reported that in different chicory genotypes, protein yield ranged from 162.1 to 200.7 g kg^{-1}.

Table 3. Dry plant weight, crude protein content and protein yield of chicory genotypes

Genotypes	Total dry plant weight**(g $plant^{-1}$)	Average crude protein content** (%)	Total protein yield**(g $plant^{-1}$)
Ams	251.90 b-e	14.37 a-g	36.19 b-e
Ant	381.00 a-e	13.67 c-g	52.08 b-e
Kır	194.00 de	11.89 g	22.98 e
K-k	354.10 a-e	11.85 g	41.96 b-e
K-m	564.60 a	15.61 a-d	88.13 a
K-t	451.00 abc	13.50 d-g	60.88 a-d
Nev	331.90 a-e	16.60 a	55.09 a-d
Sam	206.70 de	16.16 abc	33.40 b-e
Y-b1	167.90 e	14.12 a-g	23.70 de
Y-b2	245.00 cde	13.70 c-g	33.56 b-e
Y-b3	294.10 b-e	12.87 fg	37.89 b-e
Y-c1	438.20 a-d	13.85 c-g	60.69 a-d
Y-c2	186.80 e	15.71 a-d	29.34 cde
Y-k	351.50 a-e	13.90 b-g	41.85 b-e
Y-m1	255.50 b-e	14.94 a-f	38.17 b-e
Y-m2	203.80 de	13.60 c-g	27.71 cde
Y-m3	491.40 ab	14.10 a-g	69.28 ab
Y-m4	284.50 b-e	13.12 d-g	37.32 b-e
Y-m5	167.80 e	12.56 fg	21.07 e
Y-m6	229.50 cde	13.08 efg	30.01 cde
Y-sr1	404.80 a-e	15.60 a-e	63.14 a-e
Y-sr2	250.50 b-e	13.58 c-g	34.01 b-e
Y-sr3	468.90 abc	12.95 fg	60.72 a-e
Y-so1	248.20 b-e	13.78 c-g	34.20 b-e
Y-so2	187.50 e	14.26 a-g	26.73 de
Y-y1	362.70 a-e	16.44 ab	59.62 a-d
Y-y2	270.80 b-e	14.19 a-g	38.42 b-e
Y-y3	371.80 a-e	13.50 d-g	50.19 b-e
Y-y4	454.90 abc	14.75 a-f	67.09 abc
Average	312.80	14.07	43.98

**: P≤0.01, There is no difference between the same letters in each column (P<0.05)

ADF, NDF and mineral contents, except potassium, were significantly different between chicory genotypes. Average ADF and NDF ratios ranged from 28.86 to 44.08% (Y-c2) and 36.29-51.75% (K-k) (Table 4). Sulas (2004) reported that ADF content of chicory ranged from 25.8-49.9%. Labreveux et al. (2006) reported that NDF content of chicory ranged from 25.5-39.9%.

The highest potassium (K) content was determined in Y-k (2.442%), while it was lowest in Y-y1 (2.022%). The phosphorus (P), calcium (Ca) and magnesium (Mg) content of chicory genotypes ranged from 0.367 to 0.413%, 0.963 to 1.232% and 0.250 to 0.407% respectively (Table 4 and 5). Egritas and Ascı (2015) reported that minerals have significant effects on both plant and animal metabolisms. There is need more than 0.21% P, 0.3% Ca and 0.1% Mg in the feed of cows and, the need for magnesium varied between 0.1 – 0.2% (Kidambi et al., 1989).

Table 4. Average ADF, NDF, K, and P content of chicory genotypes (%)

Genotypes	ADF*	NDF**	K	P**
Ams	31.30 c-f	46.35 c-f	2.320	0.375 cde
Ant	32.14 a-f	47.19 a-f	2.215	0.387 a-e
Kır	36.38 a	51.55 ab	2.313	0.372 de
K-k	36.29 a	51.75 a	2.217	0.376 cde
K-m	31.73 b-f	46.49 c-f	2.318	0.406 ab
K-t	31.63 b-f	47.20 a-f	2.313	0.387 b-e
Nev	29.07 f	44.57 ef	2.336	0.413 a
Sam	30.61 def	46.90 b-f	2.278	0.384 b-e
Y-b1	31.64 b-f	47.53 a-f	2.229	0.381 b-e
Y-b2	32.16 a-f	46.71 c-f	2.402	0.389 a-e
Y-b3	35.14 abc	50.34 a-d	2.277	0.382 b-e
Y-c1	32.46 a-f	47.61 a-f	2.435	0.392 a-e
Y-c2	28.86 f	44.08 f	2.325	0.388 a-e
Y-k	32.06 a-f	47.37 a-f	2.442	0.391 a-e
Y-m1	31.30 c-f	46.47 c-f	2.411	0.406 ab
Y-m2	33.59a-e	48.87 a-e	2.258	0.386 b-e
Y-m3	33.50 a-e	49.55 a-d	2.275	0.394 a-d
Y-m4	34.13 a-d	49.90 a-d	2.328	0.386 b-e
Y-m5	34.82 a-d	50.69 abc	2.228	0.367 e
Y-m6	34.10 a-d	49.28 a-d	2.177	0.384 b-e
Y-sr1	29.70 ef	44.56 ef	2.391	0.404 ab
Y-sr2	32.74 a-f	47.74 a-f	2.291	0.384 b-e
Y-sr3	35.94 ab	51.67 a	2.221	0.388 a-e
Y-so1	33.88 a-e	49.82 a-d	2.340	0.382 b-e
Y-so2	34.07 a-d	50.15 a-d	2.221	0.392 a-e
Y-y1	31.56 c-f	47.66 a-f	2.022	0.399 abc
Y-y2	32.93 a-f	48.16 a-f	2.287	0.373 cde
Y-y3	33.58 a-e	49.20 a-e	2.201	0.384 b-e
Y-y4	30.77 c-f	45.79 def	2.441	0.398 a-d
Average	32.69	48.10	2.287	0.387

*: $P \leq 0.05$; **: $P \leq 0.01$, There is no difference between the same letters in each column ($p<0.05$)

K/(Ca+Mg) ratio, is a indikator for tetani desease, ranged between 1.500-1.887% among chicory genotypes. The reason of tetany is a low content of Mg in hay and the K/(Ca+Mg) content of hay is recommended to be less than 2.2% (Kidambi et al., 1989). In the study, K/(Ca+Mg) ratio in all genotypes exhibited less than critical value (Table 5).

Insufficient Ca/P ratio or low Ca content in the hay, can develop enlarged joints or even crooked long bones in animals when growing, while the low P content inf hay is causing animals rachitic (Knight et al., 1985). The ideal Ca/P ratio of hay is recommended to be less 2/1. But, if the animals take sufficient D vitamin, this ratio is tolerated to 7/1 (Barnes et al., 1990; Buxton and Fales, 1994). In the present study, the Ca/P ratio in all genotypes exhibited less than critical ratio (7/1).

Table 5. Average Ca and Mg content with K(Ca+Mg) and Ca/P ratio of chicory genotypes

Genotypes	Ca**	Mg**	K(Ca+Mg)*	Ca/P**
Ams	1.087 b-f	0.298 c-h	1.660 abc	2.907 a-e
Ant	1.070 b-f	0.296 c-h	1.609 bc	2.767 b-e
Kır	0.963 f	0.250 h	1.887 a	2.593 e
K-k	0.995 ef	0.255 g-h	1.755 ab	2.659 cde
K-m	1.145 a-d	0.343 bc	1.548 bc	2.842 a-e
K-t	1.069 b-f	0.300 c-h	1.688 abc	2.786 b-e
Nev	1.152 abc	0.363 b	1.540 bc	2.823 a-e
Sam	1.170 ab	0.361 b	1.500 c	3.044 ab
Y-b1	1.119 a-e	0.312 c-f	1.541 bc	2.973 abc
Y-b2	1.096 b-e	0.300 c-h	1.727 abc	2.823 a-e
Y-b3	1.065 b-f	0.298 c-h	1.659 abc	2.800 b-e
Y-c1	1.089 b-f	0.297 c-h	1.765 ab	2.790 b-e
Y-c2	1.140 a-d	0.329 bcd	1.589 bc	2.972 abc
Y-k	1.083 b-f	0.294 c-h	1.770 ab	2.799 b-e
Y-m1	1.058 b-f	0.284 d-h	1.778 ab	2.615 e
Y-m2	1.048 b-f	0.276 e-h	1.686 abc	2.729 cde
Y-m3	1.056 b-f	0.290 d-h	1.694 abc	2.716 cde
Y-m4	1.039 c-f	0.286 d-h	1.749 ab	2.712 cde
Y-m5	1.049 b-f	0.266 fgh	1.672 abc	2.862 a-e
Y-m6	1.039 c-f	0.265 fgh	1.668 abc	2.717 cde
Y-sr1	1.160 abc	0.324 b-e	1.627 bc	2.907 a-e
Y-sr2	1.108 b-e	0.311 c-f	1.622 bc	2.893 a-e
Y-sr3	1.038 c-f	0.287 d-h	1.674 abc	2.685 cde
Y-so1	1.057 b-f	0.279 d-h	1.734 abc	2.787 b-e
Y-so2	1.021 def	0.279 d-h	1.701 abc	2.626 de
Y-y1	1.232 a	0.407 a	1.235 d	3.121 a
Y-y2	1.126 a-d	0.316 b-f	1.600 bc	3.047 ab
Y-y3	1.112 a-e	0.313 c-f	1.554 bc	2.932 a-d
Y-y4	1.104 b-e	0.305 c-g	1.727 abc	2.803 b-e
Average	1.085	0.302	1.653	2.817

*: P≤0.05; **: P≤0.01, There is no difference between the same letters in each column (p<0.05)

Correlations between the investigated yield and quality traits of chicory genotypes are given in Table 6. The strongest correlation was observed between ADF and NDF ratio (0.979), and then it was followed by the correlation of Ca and Mg content (0.946). These correlations were significant and positive. It was also determined that there was a significant and negative correlation of P with ADF and NDF. This indicated that there was an increase in the lignin and cellulose content in chicory with decreasing mineral contents. A significant positive correlation (0.979; p<0.01) was observed between ADF and NDF while a significant and negative correlation was determined between the ADF and NDF ratio with other traits (Table 6).

Table 6. The correlation values between yield and quality traits in chicory genotypes

	CP	PY	ADF	NDF	K	P	Ca	Mg
DPW	-0.180	0.936**	-0.081	-0.121	0.138	0.182	0.505**	0.222
CP		0.161	-0.611**	-0.512**	0.057	0.546**	0.460*	0.618**
PY			-0.312	-0.318	0.165	0.378*	0.685**	0.443*
ADF				0.979**	-0.339	-0.767**	-0.591**	-0.685**
NDF					-0.424**	-0.717**	-0.587**	-0.614**
K						-0.078	0.265	-0.189
P							0.463*	0.517**
Ca								0.946**

*: P≤0.05; **: P≤0.01, There is no difference between the same letters in each column (p<0.05)

The biplot graphic analyses of the 29 chicory genotypes are present in Figure 1. The yield and quality results of the present study revealed that the first principal component (PCA 1) and the second (PCA 2) respectively exhibited 56.54% and 20.45% (totally 76.99%).

Sharifi *et al*. (2018) reported that the biplot analyses have been used to compare genotypes on the basis of multiple traits and to identify genotypes or groups that are particularly good in certain aspects, and that can be candidates for future breeding. In our study, the genotypes Ant, K-m, K-t, Y-c1, Y-k,Y-m3, Y-sr1 and Y-y4 exhibited higher values compared the others in term of DPW, PY, K and P contents. The genotypes named Nev, Sam, Y-b2, Y-c2 and Y-m1 were higher in CP, Ca and Mg content (Figure 1).

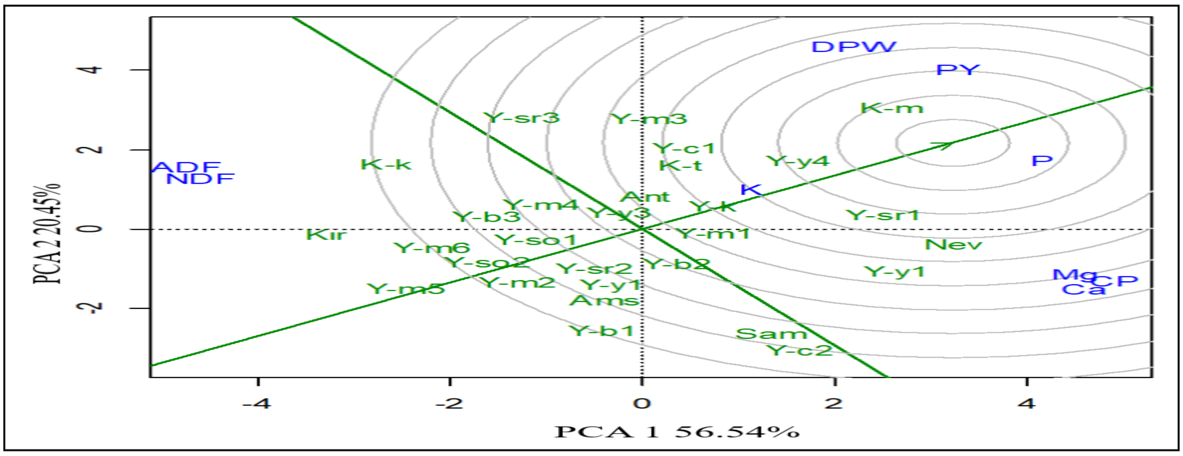

Figure 1. Dispersion of the chicory genotypes based on the first two principal components

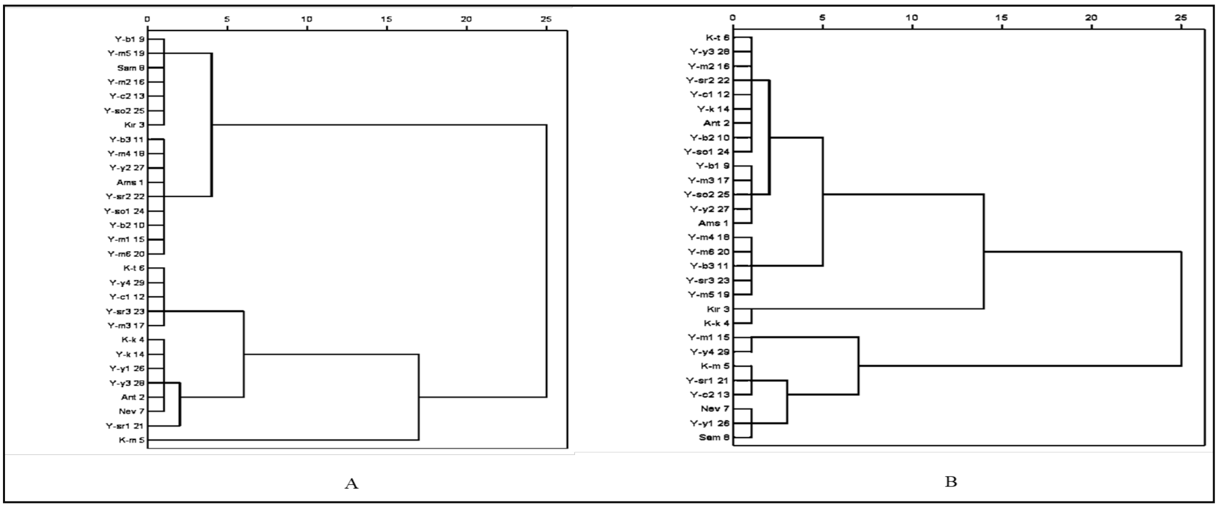

Figure 2. Dendrogram of dry plant weight (A) and crude protein content (B) of chicory genotypes

The dendrogram results of the chicory genotypes in term of crude protein content (A) and dry plant weight (B) are given in Figure 2. The dendrogram indicated that 29 chicory genotypes could be divided into three major groups in terms of dry plant weight and crude protein content. Also, the diagrams exhibited eight subgroups for dry plant weight and seven subgroups for crude protein content. Regarding to the dry plant weight; the genotypes (Ams, Kır, Sam, Y-b1, Y-b2, Y-b3, Y-c2, Y-m1, Y-m2, Y-m4, Y-m5, Y-m6, Y-sr2, Y-so1, Y-so2 and Y-y2) with low dry plant weight grouped in the first group. The genotypes with moderate dry plant weight (Ant, K-k, K-t, Nev, Y-c1, Y-k, Y-m3, Y-sr1, Y-sr3, Y-y1, Y-y3 and Y-y4) was the second group, while the third group included of K-m genotype which is high in dry plant weight. Regarding to the crude protein content; first group consisted of K-t, Y-y3, Y-m2, Y-sr2, Y-c1, Y-k, Ant, Y-b2, Y-so1, Y-b1, Y-m3, Y-so2, Y-y2, Ams, Y-m4, Y-m6, Y-b3, Y-sr3 and Y-m5 genotypes which are low in crude protein content while the second group included Kır and K-k genotypes which have moderate crude protein content. The genotypes with high crude protein content (Y-mt, Y-y4, K-m, Y-sr1, Y-c2, Nev, Y-y1 and Sam) were in in the third group (Figure 2).

4. Conclusion

In Turkey, the summer periods have needs in quality fresh forage, since cool-season forages are dormant periods. *Cichorium intybus* L. is shows extremely tolerance to the high temperature and drought due to its capability to elongate and protect its greenery during the summer and so it can be provide fresh and quality feed to animals this period. The obtained highly significant differences among the chicory genotypes for yield and quality is promising for future breeding study, especially with regarding the genotypes K-m, K-t, Y-c1, Y-k, Y-sr1 and Y-y4. Additionally, we are hope that this research which is one of the first studies about this area will lighten the next studies.

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