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Research Article/Araştırma Makalesi

Evaluation of some forage pea (*Pisum arvense* L.) lines and cultivars in terms of herbage yield and quality

Bazı yem bezelyesi hat ve çeşitlerinin (Pisum arvense L.) ot verimi ve kalitesi açısından değerlendirilmesi

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ABSTRACT

This study was conducted to determine some yield, quality attributes and correlation of forage pea lines and cultivars for two years between 2014 and 2015 in Bingöl ecological conditions. In present experiments, fourteen different forage pea lines and cultivars were used as the plant material. Experiments were conducted in randomized complete blocks design with three replications. Plant height, herbage yield, hay yield, crude protein ratio, crude protein yield, crude ash ratio, acid detergent fiber, neutral detergent fiber, digestible dry matter, dry matter intake and relative feed value were investigated. According to mean of experimental years plant height, herbage yield, hay yield, crude protein ratio, crude protein yield, crude ash ratio, acid detergent fiber, neutral detergent fiber, digestible dry matter, dry matter intake and relative feed values varied from 38.4 to 92.0 cm, from 874 to 1552 kg da^{-1}, from 129 to 232 kg da^{-1}, from 10.2 to 16.9%, from 15.8 to 38.4 kg da^{-1}, from 9.1 to 11.6%, from 27.6 to 34.9%, from 38.1 to 44.1%, from 61.7 to 67.4%, from 2.73 to 3.18% and from 130.9 to 166.4. Significant correlations were found between the traits studied. In terms of these parameters; the Urunlu and Retna genotypes were found to be superior.

Key Words: ADF, NDF, Correlation, Crude protein, Forage pea

ÖZ

Bu çalışma, Bingöl ekolojik koşullarında bazı yem bezelyesi hat ve çeşitlerinin ot verimi, kalitesi ve aralarındaki korelasyonun belirlenmesi amacıyla 2014-2015 yıllarında iki yıl süreyle yürütülmüştür. Çalışmada materyal olarak 14 adet yem bezelyesi hat ve çeşidi kullanılmıştır. Araştırma tesadüf blokları deneme desenine göre üç tekerrürlü olarak kurulmuştur. Araştırmada; bitki boyu, yeşil ot verimi, kuru ot verimi, ham protein oranı, ham protein verimi, ham kül oranı, asit deterjanda çözünmeyen lif, nötral deterjanda çözünmeyen lif, sindirilebilir kuru madde, kuru madde tüketimi ve nispi yem değerlerine ilişkin veriler ele alınmıştır. Araştırma sonucunda ortalama olarak; bitki boyu 38.4-92.0 cm, yeşil ot verimi 874-1552 kg/da, kuru ot verimi 129-232 kg/da, ham protein oranı %10.2-16.9, ham protein verimi 15.8-38.4 kg/da, ham kül oranı %9.1-11.6, asit deterjanda çözünmeyen lif %27.6-34.9, nötral deterjanda çözünmeyen lif %38.1-44.1, sindirilebilir kuru madde %61.7-67.4, kuru madde tüketimi %2.73-3.18 ve nispi yem değeri 130.9-166.4 arasında değişmiştir. İncelenen özellikler arasında önemli seviyede korelasyon olduğu belirlenmiştir. Bu parametreler açısından; Ürünlü ve Retna genotiplerinin üstün özellikler göstererek öne çıktığı tespit edilmiştir.

Anahtar Kelimeler: ADF, NDF, Korelasyon, Ham protein, Yem bezelyesi

Introduction

Peas are gathered under *Pisum sativum* species. *Pisum sativum* ssp. *sativum* sb-species are grown for fresh or dry grains either as edible peas or garden peas. Grains have quite high sugar contents and they are commonly used edible grain legumes. Field pea, also known as forage pea (*Pisum sativum* ssp. *arvense*) is grown for hay production, grazing or green-fertilization (Acikgoz, 2001; Avcioglu et al., 2009).

Forage pea is a multi-purpose plant. It is quite available for production as an interim product in temperate zones. Since it has quite short growth period, it is commonly preferred in crop rotations and it can serve as a quite well precursor plant for the other plants in rotation. Forage pea is also used as herbage, hay and silage. It is also quite available to be used as manure crop. It had high yield levels and easily degraded in soil, therefore, can reliably be used as manure crops. In coastal regions, forage pea can be intercropped with cereals in autumn, winter and early spring months and can be used as a short-term pasture with heavy grazing activities (Acar and Ayan, 2012).

Pea herbage is quite palatable and nutritious for almost all animals. Hay harvested at proper harvest period has around 20% crude protein content. Herbage yield per decare under dry conditions is around 1 ton and hay yield is around 250-300 kg. Herbage yield may reach to 2-4 ton da^{-1} under irrigated conditions or in coastal zones (Acikgoz, 2001; Avcioglu et al., 2009; Acikgoz, 2013).

In this study, herbage and hay yields and herbage quality parameters of 14 pea lines and cultivars were investigated to get high quantity and quality yields from pea cultivation and to reveal the correlation between yield and quality parameters of these lines and cultivars.

Material and Method

This study was carried out at research and experiment fields of Bingol University under dry conditions for two years (2014-2015). A total of 6 pea lines (88-PO38-4-3-683, Spring Pea 3-638, P57B, P51, P101, P104) and 8 pea cultivars (Atos, Ozkaynak, Retna, Gatem, Spring, Bolero, Urunlu and Golyazı) were used as the plant material of the study.

Field experiments were set in April of both years and experiments were conducted in randomized blocks design with three replications. Experimental plots were 5 m long and there were 6 rows 30 cm apart in each plot. Sowing was performed with a hand marker. Seeding rate was arranged as to have 15 kg da^{-1} seeds per decare. Before sowing, 4 kg da^{-1} nitrogen and 10 kg da^{-1} phosphorus were applied to experimental plots. Harvests were performed in second week of June of both years.

According to long-term climate data (1990-2015), monthly average temperature of Bingol province is 12.3 °C, total precipitation is 950.8 mm and average relative humidity is 56.9%. In experimental years (2014-2015), average temperature (13.7°C in 2014 and 2015) and relative humidity (51.9% in 2014 and 52.7% in 2015) were close to long-term averages. However, precipitations in experimental years (758 mm in 2014 and 802 mm in 2015) were lower than long-term averages.

Soil samples were taken from 10 different locations of experimental fields. Samples were analyzed at Soil-plant Analysis Laboratory at Agricultural Faculty of Bingol University. Analysis results were assessed based on limit values specified in Sezen (1995) and Karaman (2012). Soil texture was identified as loamy (with degree of saturation of 43.31%); soils were slightly acidic (pH = 6.37), unsaline (0.0066%), poor in organic matter (1.26%), lime (0.15%), potassium (24.45 kg da^{-1}) and medium in phosphorus (7.91 kg da^{-1}).

Plants heights were determined on randomly selected 10 plants from each plot as the height from the soil surface to the last bud. Herbage samples from each plot were weighed to get herbage yields. Then, plot yields were converted into yields per decare. Herbage samples (0.5 kg from each plot) were dried at 70 $^{\circ}$C for 48 hours and weighed to get hay yields (Anonymous,

2016). Then, yields were again converted into hay yields per decare. Plant samples from hay were ground to pass through 1 mm sieve. Crude ash content of samples was determined by ashing the samples at 550 ^{o}C for 8 hours. Kjeldahl method was used to determine nitrogen (N) contents of the samples. Then, nitrogen content was multiplied by 6.25 to get crude protein ratios (AOAC, 1990). Acid detergent fiber (NDF) and neutral detergent fiber (ADF) values were determined with ANKOM 200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA) device (Van Soest et al., 1991). With resultant ADF and NDF values, digestible dry matter content (DDM=88.9 - (0.779 x %ADF)), dry matter intake (DMI=120 / %NDF) and relative feed value (RFV=(DMI x DMD) / 1.29) were calculated (Morrison, 2003).

Experimental data were subjected to variance analysis (with SAS software) in accordance with randomized blocks design with 3 replications. Significant factor means were compared with Duncan's (5%) multiple range test. Basic correlation coefficients were calculated to identify the relationships among investigated parameters.

Results and Discussion

In the study, highly significant differences were observed in all attributes ($p<0.01$).

Plant height and crude ash content

Plant heights and crude ash contents of pea samples are provided in Table 1. As the average of two years, the greatest plant height (92.0 cm) was obtained from Golyazı cultivar and the lowest plant heights were obtained from Bolero, Spring, Atos and Retna genotypes. Two-year average plant height was calculated as 62.9 cm.

The greatest crude ash content (11.6%) was obtained from Spring genotype. It was followed by Spring Pea 3-638, Urunlu and P104 genotypes respectively with same statistical group. The lowest crude ash ratios were observed in P57B, 88-PO38-4-3-683 and P101 genotypes. Two-year average crude ash ratio was calculated as 10.4%. With regard to the years, the highest crude ash ratios were obtained from 2014 and the lowest crude ash ratios were obtained from 2015.

Table 1. Plant height and crude ash ratios of forage pea genotypes for 2014 and 2015 years and averages
Çizelge 1. Yem bezelyesi genotiplerinin 2014 ve 2015 yılları ve ortalamalarına ait bitki boyu ve ham kül oranları

No	Lines and Cultivars *Hat ve Çeşitler*	Plant Height (cm) *Bitki boyu (cm)*			Crude Ash (%) *Ham kül (%)*		
		2014	2015	Mean *Ortalama*	2014	2015	Mean *Ortalama*
1	88 PO38-4-3-683	57.9	59.1	58.5 e**	9.6	8.8	9.2 e**
2	Spring PEA 3-638	80.8	43.4	62.1 de	13.9	8.7	11.3 ab
3	P57B	71.1	74.3	72.7 c	10.5	7.7	9.1 e
4	P51	65.7	68.1	66.9 cd	11.2	9.4	10.3 cd
5	P101	83.4	83.4	83.4 b	11.3	7.5	9.4 e
6	P104	81.1	84.9	83.0 b	12.3	9.3	10.8 abc
7	Atos	42.0	41.4	41.7 f	11.8	8.8	10.3 cd
8	Ozkaynak	57.9	60.1	59.0 e	11.6	9.6	10.6 bc
9	Retna	41.0	42.6	41.8 f	10.1	10.5	10.3 cd
10	Gatem 101	68.1	70.1	69.1 c	10.1	10.5	10.3 cd
11	Spring	38.7	41.5	40.1 f	11.1	12.1	11.6 a
12	Bolero	38.6	38.2	38.4 f	11.1	10.1	10.6 bc
13	Urunlu	72.4	72.2	72.3 c	12.6	9.8	11.2 ab
14	Golyazı	89.1	94.9	92.0 a	11.4	8.2	9.8 de
	Mean	63.4	62.4	62.9	11.3 A**	9.4 B	10.4

Significance at P≤0.01, CV (plant height): %10.60, CV (crude ash): %10.09 / *%1 seviyesinde önemli*

In previous studies, plant heights were reported as between 39.2-79.6 cm (Gul et al., 2005; Togay et al., 2006; Sayar and Anlarsal, 2008; Sayar et al., 2009). Crude ash ratios were

reported as between 6.98-9.56% (Ozyigit and Bilgen, 2006; Kavut et al., 2016). While present plant heights were complying with earlier findings, crude ash ratios were slightly higher than previous findings.

Herbage and hay yields

Herbage and hay yields of pea genotypes are provided in Table 2. As the average of two years, the greatest herbage yield was obtained from Urunlu (1552 kg da^{-1}) cultivar and the lowest herbage yields were obtained from Spring, P57B, 88-PO38-4-3-683 and P51 genotypes. Two-year average herbage yield was calculated as 1147 kg da^{-1}.

The greatest hay yield was obtained from P101 genotype (232 kg da^{-1}) and the lowest hay yields were obtained from Spring and 88 P038-4-3-683 genotypes. Two-year average hay yield of genotypes was calculated as 179 kg da^{-1}. In 2014, higher herbage and hay yields were obtained than the 2015 year.

In previous studies, herbage and hay yields were reported respectively as between 884-5275 kg da^{-1} and between 189-960 kg da^{-1} (Timuragaoglu et al., 2004; Sayar and Anlarsal, 2008; Sayar et al., 2009; Geren and Alan, 2012). Present findings were slightly lower than earlier findings since previous genotypes were sown in winter.

Table 2. Herbage yield and hay yield of forage pea genotypes for 2014 and 2015 years and averages
Çizelge 2. Yem bezelyesi genotiplerinin 2014 ve 2015 yılları ve ortalamalarına ait yeşil ot ve kuru ot verimleri

No	Lines and Cultivars *Hat ve Çeşitler*	Herbage yield (kg da^{-1}) *Yeşil ot verimi (kg da^{-1})*			Hay yield (kg da^{-1}) *Kuru ot verimi (kg da^{-1})*		
		2014	2015	Mean *Ortalama*	2014	2015	Mean *Ortalama*
1	88 PO38-4-3-683	1076	723	900 i**	162	109	136 f**
2	Spring PEA 3-638	1295	952	1123 ef	223	156	190 c
3	P57B	1053	724	888 i	184	124	154 e
4	P51	1063	757	910 i	181	122	152 e
5	P101	1406	1007	1206 d	279	185	232 a
6	P104	1189	845	1017 h	206	148	177 d
7	Atos	1191	889	1040 gh	202	147	175 d
8	Ozkaynak	1381	1004	1192 de	207	147	177 d
9	Retna	1677	1243	1460 b	248	174	211 b
10	Gatem 101	1670	1179	1424 bc	243	172	207 b
11	Spring	1012	736	874 i	151	108	129 f
12	Bolero	1222	966	1094 gf	161	135	148 e
13	Urunlu	1829	1274	1552 a	253	174	213 b
14	Golyazı	1642	1116	1379 c	244	173	209 b
	Mean	1336 A**	958 B	1147	210 A**	148 B	179

Significance at P≤0.01, CV (herbage): %5.20, CV (hay): %6.49 / *%1 seviyesinde önemli*

Crude protein ratio and crude protein yield

Crude protein ratios and crude protein yields of pea genotypes are provided in Table 3. As the average of two years, the greatest crude protein ratio (16.9%) was obtained from Urunlu cultivar and the lowest crude protein ratio was obtained from P101 genotype. Two-year average crude protein ratio of the genotypes was calculated as 12.7%.

The greatest crude protein yield (38.4 kg da^{-1}) was obtained from Urunlu cultivar and the lowest crude protein yields were obtained from 88-PO38-4-3-683, P51, Spring and P57B genotypes. Two-year average crude protein yield of the genotypes was calculated as 23.6 kg da^{-1}. In 2014, higher crude protein ratio and crude protein yields were obtained than the 2015 year.

Crude protein ratios were reported as between 14.6-19.0% (Timuragaoglu et al., 2004; Uzun et al., 2012; Tan et al., 2013). Crude protein yields were reported as between 65.0-97.9 kg da-^{1} (Timuragaoglu et al., 2004; Uzun et al., 2012). Different environmental conditions and fertilizers may result in different crude protein ratios and consequently different crude protein yields. Low hay yields may also result in low crude protein yields.

Table 3. Crude protein ratio and crude protein yield of forage pea genotypes for 2014 and 2015 years and averages
Çizelge 3. Yem bezelyesi genotiplerinin 2014 ve 2015 yılları ve ortalamalarına ait ham protein oranı ve ham protein verimleri

No	Lines and Cultivars *Hat ve Çeşitler*	Crude protein ratio (%) *Ham protein oranı (%)*			Crude protein yield (kg da^{-1}) *Ham protein verimi (kg da^{-1})*		
		2014	2015	Mean *Ortalama*	2014	2015	Mean *Ortalama*
1	88 PO38-4-3-683	13.3	9.3	11.3 efg**	21.5	10.1	15.8 c**
2	Spring PEA 3-638	17.9	9.9	13.9 c	39.9	15.4	27.6 b
3	P57B	12.4	9.7	11.0 fgh	22.8	12.0	17.4 c
4	P51	10.0	11.3	10.6 gh	18.0	13.8	15.9 c
5	P101	10.8	9.6	10.2 h	30.1	17.8	23.9 bc
6	P104	16.6	7.6	12.1 de	34.2	11.3	22.8 bc
7	Atos	16.7	11.5	14.1 c	33.6	17.0	25.3 bc
8	Ozkaynak	17.1	10.2	13.6 c	35.4	14.9	25.2 bc
9	Retna	16.2	10.0	13.1 cd	40.1	17.4	28.8 ab
10	Gatem 101	14.0	9.6	11.8 ef	34.0	16.6	25.3 bc
11	Spring	16.3	9.9	13.1 cd	24.6	10.7	17.6 c
12	Bolero	16.6	13.8	15.2 b	26.7	18.6	22.6 bc
13	Urunlu	22.8	11.0	16.9 a	57.7	19.1	38.4 a
14	Golyazı	12.4	10.7	11.5 efg	30.2	18.5	24.4 bc
	Mean	15,2 A**	10.3 B	12.7	32.1 A**	15.2 B	23.6

Significance at P≤0.01, CV (protein): %15.28, CV (protein yield): %20.67 / *%1 seviyesinde önemli*

Acid detergent fiber and neutral detergent fiber ratios

ADF and NDF ratios of pea genotypes are provided in Table 4. As the average of two years, the lowest ADF ratio (27.6%) was obtained from Retna genotype and it was followed by Spring Pea 3-638, Bolero and Spring genotypes which were placed in the same statistical group. The greatest ADF ratio was obtained from P57B genotype. Two-year average ADF ratio of the genotypes was calculated as 31.6%.

Table 4. Acid detergent fiber and neutral detergent fiber ratios of forage pea genotypes for 2014 and 2015 years and averages
Çizelge 4. Yem bezelyesi genotiplerinin 2014 ve 2015 yılları ve ortalamalarına ait asit deterjanda ve nötral deterjanda çözünmeyen lif oranları

No	Lines and Cultivars *Hat ve Çeşitler*	ADF (%) *ADF (%)*			NDF (%) *NDF (%)*		
		2014	2015	Mean *Ortalama*	2014	2015	Mean *Ortalama*
1	88 PO38-4-3-683	33.4	31.2	32.3 abc**	41.4	41.5	41.4 b-e**
2	Spring PEA 3-638	27.0	30.4	28.7 de	42.4	38.0	40.2 c-f
3	P57B	35.2	34.6	34.9 a	42.0	46.0	44.0 a
4	P51	34.4	30.2	32.3 abc	45.5	41.2	43.3 ab
5	P101	33.2	33.7	33.4 ab	43.4	44.8	44.1 a
6	P104	29.8	35.0	32.4 abc	37.9	44.3	41.1 b-e
7	Atos	33.7	30.5	32.1 abc	41.0	37.2	39.1 ef
8	Ozkaynak	30.4	34.8	32.6 abc	41.2	43.8	42.5 abc
9	Retna	26.4	28.8	27.6 e	34.1	42.1	38.1 f
10	Gatem 101	29.4	33.4	31.4 bcd	37.3	42.9	40.1 def
11	Spring	27.6	33.4	30.5 b-e	40.1	43.3	41.7 bcd
12	Bolero	30.9	27.8	29.3 cde	40.8	44.0	42.4 a-d
13	Urunlu	27.8	34.3	31.0 bcd	38.5	42.1	40.3 c-f
14	Golyazı	33.8	32.6	33.2 ab	42.7	40.1	41.4 b-e
	Mean	30.9 B	32.2 A*	31.6	40.6 B	42.2 A**	41.4

*Significant at P≤0.05, **Significance at P≤0.01, CV (ADF): %8.26, CV (NDF): %5.98 / **%5 seviyesinde, **%1 seviyesinde önemli*

The lowest NDF ratio (38.1%) was obtained from Retna genotype and it was followed by Atos, Gatem, Urunlu and Spring Pea 3-638 genotypes which were placed in the same statistical group.

The greatest NDF ratios were obtained from P101 and P57B genotypes. Two-year average NDF ratio of the genotypes was calculated as 41.4%. In 2015, higher ADF and NDF ratios were obtained than the 2014 year.

ADF and NDF ratios were reported respectively as between 21.5-40.5% and between 32.3-54.3% (Ates, 2012; Tan et al., 2013; Asci et al., 2015). Present findings were quite similar with those earlier ones.

Digestible dry matter, dry matter intake and relative feed value

DDM and DMI ratios of pea genotypes are provided Table 5. As the average of two years, the greatest DDM ratio (67.4%) was obtained from Retna genotype and it was followed by Spring Pea 3-638, Bolero and Spring genotypes which were placed in the same statistical group. The lowest DDM ratio was obtained from P57B genotype. Two-year average DDM ratio of the genotypes was calculated as 64.3%.

Table 5. Digestible dry matter and dry matter intake ratios of forage pea genotypes for 2014 and 2015 years and averages
Çizelge 5. Yem bezelyesi genotiplerinin 2014 ve 2015 yılları ve ortalamalarına ait sindirilebilir kuru madde ve kuru madde tüketimi oranları

No	Lines and Cultivars *Hat ve Çeşitler*	DDM (%) *SKM (%)*			DMI (%) *KMT (%)*		
		2014	2015	Mean *Ortalama*	2014	2015	Mean *Ortalama*
1	88 PO38-4-3-683	62.9	64.6	63.7 cde**	2.90	2.90	2.90 cde**
2	Spring PEA 3-638	67.9	65.2	66.5 ab	2.83	3.17	3.00 bc
3	P57B	61.5	61.9	61.7 e	2.86	2.62	2.74 e
4	P51	62.1	65.4	63.7 cde	2.64	2.92	2.78 de
5	P101	63.0	62.7	62.8 de	2.77	2.69	2.73 e
6	P104	65.7	61.7	63.7 cde	3.16	2.71	2.94 bcd
7	Atos	62.7	65.1	63.9 cde	2.93	3.26	3.09 ab
8	Ozkaynak	65.2	61.8	63.5 cde	2.91	2.74	2.83 cde
9	Retna	68.4	66.5	67.4 a	3.51	2.85	3.18 a
10	Gatem 101	66.0	62.8	64.5 bcd	3.22	2.80	3.01 bc
11	Spring	67.4	62.9	65.1 a-d	2.99	2.77	2.88 cde
12	Bolero	64.8	67.3	66.1 abc	2.94	2.73	2.83 cde
13	Urunlu	67.3	62.2	64.8 bcd	3.11	2.85	2.98 bc
14	Golyazı	62.6	63.5	63.0 de	2.81	2.99	2.90 cde
	Mean	64.8 A*	63.8 B	64.3	2.97 A**	2.86 B	2.91

*Significant at P≤0.05, **Significance at P≤0.01, CV (DDM): %3.16, CV (DMI): %6.43 / **%5 seviyesinde **%1 seviyesinde önemli*

Table 6. Relative feed value of forage pea genotypes for 2014 and 2015 years and averages
Çizelge 6. Yem bezelyesi genotiplerinin 2014 ve 2015 yılları ve ortalamalarına ait nispi yem değeri

No	Lines and Cultivars *Hat ve Çeşitler*	RFV / *NYD*		
		2014	2015	Mean / *Ortalama*
1	88 PO38-4-3-683	141.4	145.2	143.3 b-f**
2	Spring PEA 3-638	149.0	160.0	154.5 b
3	P57B	136.2	125.5	130.9 g
4	P51	127.0	147.8	137.4 efg
5	P101	135.2	130.8	133.0 fg
6	P104	161.1	129.7	145.4 b-e
7	Atos	142.3	164.8	153.6 bc
8	Ozkaynak	147.3	131.4	139.4 d-g
9	Retna	186.2	146.8	166.4 a
10	Gatem 101	164.6	136.6	150.6 bcd
11	Spring	156.3	135.0	145.6 b-e
12	Bolero	147.9	142.2	145.0 b-e
13	Urunlu	162.3	137.7	150.0 bcd
14	Golyazı	136.2	147.3	141.9 c-g
	Mean	149.5 A**	141.5 B	145.5

Significance at P≤0.01, CV (RFV): %8.45 / *%1 seviyesinde önemli*

The greatest DMI ratio (3.18%) was obtained from Retna genotype and it was followed by Atos genotype which was placed in the same statistical group. The lowest DMI ratios were obtained from P101 and P57B genotypes. Two-year average DMI ratio of the genotypes was calculated as 2.91%.

RFV ratios of pea genotypes are provided Table 6. The greatest RFV (166.4) was obtained from Retna genotype and the lowest RFV was obtained from P57B genotype. Two-year average RFV of the genotypes was calculated as 145.5. In 2014, higher DDM, DMI and RFV ratios were obtained than the 2015 year.

Kocer and Albayrak (2012) carried out an intercropping study and reported DDM ratio of pure stand forage pea as 68.03% and RFV as 167.27. Current findings were similar with those earlier ones.

Correlations analysis between in investigated traits

Basic correlation coefficients calculated for correlations between investigated traits are provided in Table 7. Plant height had significant positive correlations with hay yield and ADF ratios. Plant heights had also significant positive correlations with herbage yield and NDF ratios. Plant height had negative correlations with crude protein ratio, DDM, DMI and RFV.

Herbage yield had highly significant positive correlations with hay yield and crude protein yield, had significant positive correlations with DMI and RFV and had significant negative correlation with NDF. There were highly significant positive correlations between hay yield and crude protein yields. Crude protein ratio had highly significant positive correlations with crude protein yield, crude ash, DDM, DMI and RFV and had highly significant negative correlations with ADF and NDF.

Table 7. Correlations analysis between investigated traits[+]
Çizelge 7. İncelenen özellikler arasındaki korelasyon analizi

	HEY *YOV*	HAY *KOV*	CP *HP*	CPY *HPV*	CA *HK*	ADF *ADF*	NDF *NDF*	DDM *SKM*	DMI *KMT*	RFV *NYD*
PH *BB*	0.219 *	0.461 **	-0.258 *	0.035	-0.204	0.369 **	0.242 *	-0.369 **	-0.242 *	-0.315 **
HEY *YOV*		0.826 **	0.059	0.501 **	-0.067	-0.149	-0.215 *	0.149	0.216 *	0.217 *
HAY *KOV*			-0.098	0.449 **	-0.123	-0.010	-0.109	0.010	0.123	0.099
CP *HP*				0.835 **	0.625 **	-0.532 **	-0.472 **	0.532 **	0.449 **	0.527 **
CPY *HPV*					0.492 **	-0.480 **	-0.486 **	0.480 **	0.477 **	0.532 **
CA *HK*						-0.248 *	-0.094	0.248 *	0.062	0.133
ADF *ADF*							0.579 **	-1.000 **	-0.571 **	-0.787 **
NDF *NDF*								-0.580 **	-0.994 **	-0.951 **
DDM *SKM*									0.571 **	0.787 **
DMI *KMT*										0.955 **

+ Correlation coefficients for 2014 and 2015, * Significant at 5%, ** Significant at 1%

PH: Plant height, HEY: Herbage yield, HAY: Hay yield, CP: Crude protein ratio, CPY: Crude protein yield, CA: Crude ash, ADF: Acid detergent fiber, NDF: Neutral detergent fiber, DDM: Digestible dry matter, DMI: Dry matter intake, RFV: Relative feed value.

*+ 2014 ve 2015 yılları için korelasyon katsayıları * %5 düzeyinde önemli, ** %1 düzeyinde önemli,*

BB: Bitki boyu, YOV: Yeşil ot verimi, KOV: Kuru ot verimi, HP: Ham protein oranı, HPV: Ham protein verimi, HK: Ham kül, ADF: Asit deterjanda çözünmeyen lif, NDF: Nötral deterjanda çözünmeyen lif, SKM: Sindirilebilir kuru madde, KMT: Kuru madde tüketimi, NYD: Nispi yem değeri

Crude protein yield had highly significant positive correlations with crude ash, DDM, DMI and RFV and had highly significant negative correlations with ADF and NDF. There were significant positive correlations between crude ash and DDM and significant negative correlations between crude ash and ADF. ADF ratio had highly significant positive correlations with NDF and had highly significant negative correlations with DDM, DMI and RFV. NDF had highly significant negative correlations with DDM, DMI and RFV. DDM had highly significant positive correlations with DMI and RFV. There were also highly significant positive correlations between DMI and RFV.

Conclusion

Significant correlations were found between yield and quality attributes in the study. In present study, the highest plant height was obtained from Golyazı, the greatest herbage yield, crude protein ratio and crude protein yield from Urunlu, the greatest hay yield from P101, the lowest ADF and NDF ratios and the greatest DDM, DMI and RFV from Retna genotypes. Considering present findings, Urunlu cultivar with higher herbage yield, crude protein ratio and crude protein yield and Retna cultivar with low ADF and NDF ratios and higher DDM, DMI and RFV showed superior properties. As such, Urunlu and Retna can be recommended for forage pea culture.

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