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PERFORMANCES OF SOME WINTER HUNGARIAN VETCH ACCESSIONS (*Vicia pannonica* Crantz.) ON THE HIGHLANDS OF TURKEY

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ABSTRACT

This study was conducted to investigate green herbage, hay yield, seed yields, and yield components of some Hungarian vetch accessions during the 2006-2007 and 2007–2008 cropping seasons at two locations (Haymana and Yenimahalle) of Ankara province. Green herbage yield, hay yield, biological yield, seed yield, plant height, number of pods per plant, number of seeds per pod and harvest index were detected. There were high correlations (P<0.01) between hay yield with main stem length, natural plant length, green herbage yield, but it had negative significant correlations with (P<0.01) pod numbers in a plant, seed numbers in a plant, pod length. The seed yield (SY) had statistically positive significant correlations (P<0.01 and P < 0.05) with main stem length (MSL), biological yield (BY), natural plant height (NPH), and hay yield (HY). Cluster analysis formed all traits measured into four groups. The results showed that three lines (L-1724, L-1725, and L-1727) were promising for yield potential, good quality, adaptation, and could be useful to meet the needs of high quality herbage production for livestock section in Turkey.

Key words: Hungarian vetch, green herbage yield, hay yield, correlations, cluster analysis

INTRODUCTION

Turkey has totally 1.27 million hectares of forage crop acreage (Anonymous, 2009a). Annual forage requirement of livestock section in Turkey is estimated as 50 million tons of good quality forage. Actual national production of the forage is about 7.15 million tones. This amount meets only 14.29 % of total requirement (Anonymous, 2009a). Vetch sown area is 0.58 million hectares, which takes the first place in the grown areas of forages crops. Thus, there is about 85 % of forage shortage in country level. Vetch is commonly grown in the Central Anatolia and Transition Regions (CAT) of Turkey (Acıkgoz, 2001). Vetches can be sown in the twice of **a**utumn and spring acreage so that they are promising potential for the production of annual herbage requirement of Turkey. Hungarian vetch is winter-hardy and drought resistant, which has high herbage yields with tiny plentiful and palatable leaves. Hungarian vetch has a good quality hay with high crude protein (21.5- 23.2% in this study). It can be easily grown alone or in mixtures with cereals (oat, rye and barley) (Murat et al. 2001; Tuğba et al. 2007; Tuna and Orak 2007).

The fallow-cereal cropping system is common in the conventional cropping system under semi-arid areas of Turkey. Research showed that winter production in fallow lands is a good opportunity for farmers. Hungarian vetch in the rotation with wheat and barley doesn't result in yield decrease for wheat grain yield under rainfed condition in Central Anatolia (Avçin and Avcı, 1993; Ünver, et al. 2001). Moreover, forages can also be produced on marginal cropland where cereal yields have generally low potential (Anonymous, 2009b).

The livestock feed shortage is still a reality in the country. For this reason, some measures should be taken and immediately put into practice. For examples, various supports farmers for fodder crop production, good seed multiplying techniques, effective extension service, and research on breeding, multidisciplinary work approaches. In Turkey, there are many studies on Hungarian vetch so far such as morphology (Orak et al. 2004) agronomic characters (Orak and Tuna 1994; Ünver et al. 2001; Uzun et al. 2004; Avcı et al. 2005; Yolcu et al. 2009), breeding (Orak and Nizam 2003; Orak et al 2005), and quality (Ünver et al. 2000 ; Yolcu et al. 2009).

The objective of this study was to determine promising lines that are well adapted to local conditions before releasing and distributing them to farmers. For this purpose, four new accessions of Hungarian vetch with white flower were studied including check variety as Tarmbeyazı-98 for the determination of their yield and other related traits in the Central Anatolian Highlands of Turkey.

MATERIALS AND METHODS

The field trials were carried out at the Yenimahalle and Haymana locations of The Central Research Institute for the Field Crops in 2006- 2007 and 2007-2008.

Yield trials with five Hungarian vetch accessions (four experimental lines, L-1724, L-1725, L-1726, L-1727, and check variety-Tarmbeyazı-98) were sown in a randomized complete block design with 3 replications.

Seeds were sown by hand. The plot size was 3.0 m x 5.0 m=15.0 m^2, consisting of 12 rows spaced at 25 cm for green herbage and biomass. The experiments at the both locations were established in a fallow field.

After seeding (12 October 2006 - 4 October 2007 in Yenimahalle and, 5 October 2006- 27 September 2007 in Haymana), 18 kg N, and 46 kg P_2O_5 ha^{-1} were applied, mixed into the soil and the upper layer of soil was pressed with plowing roller. Weed control was performed by hand hoeing when necessary.

Cutting dates for green herbage at Yenimahalle and Haymana were at the dates of 9 May 2007 - 14- 16 May 2008 and 31 May 2007 -26 May 2008. Harvesting times of seed yield at Yenimahalle and Haymana were 7 June 2007 - 19 June 2008 and 5/6 July 2007- 07 June 2008, respectively.

At the flowering stage of each accession, 5 plants were sampled and measured from each plot for the plant characters. After that, a 6.0 m^2 of 7.5 m^2 of each plots was harvested for green herbage and samples (each 500g) were dried at 70 ^{o} C for 48 h.

Before the biological harvest, 5 plants were also measured from each plot for some plant traits . A 6.0 m^2 size of the remaining plots were harvested by hand for biological yield at seed maturation time and threshed by plot harvester (thresher). Seed yield and harvest index were determined after cleaning the seeds.

The soil of the experimental site in Yenimahalle had a clay of texture, neutral, poor in organic matter, but moderate in lime content. The soil of Haymana site was clay of textured, slightly alkaline, poor in organic matter, but high in lime content. Soil features of two sites were found to be different in pH and lime content (Anonymous, 2007).

During the experimental seasons of 2006-2007 and 2007-2008, total rainfall, average temperatures and average relative humidity were 315.7 mm and 295.8 mm; 220.5 mm and 316.6 mm; 12.9 ^{o}C and 12.8 ^{o}C; 10.8 ^{o}C and 10.0 ^{o}C; 55.6 % and 54.8 %; 65.20 % and 58.90 % at Yenimahalle and Haymana, respectively (Table 1). Yenimahalle location received higher rainfall than Haymana location but had higher temperature and lower humidity.

Table.1 Precipitation (P), average temperature (AT) and relative humidity (RH) during the seasons of 2006-2007, 2007-2008 and long- term at Yenimahalle and Haymana *

			Months												
			9	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Average/ Total**
Haymana	2006-2007 season	P (mm)	51	37	7.4	1	11.2	6.8	41.2	10.4	6.6	30.8	2.2	14.9	**220.5**
		AT (^{o}C)	16.5	12.3	3.7	-2.5	0	0.2	5.2	7.3	18.1	20	24.3	24.4	**10.8**
		RH (%)	62.1	79.6	84.2	80	77.9	84	73	64.6	48.7	55.3	33.9	39.5	**65.2**
	2007-2008 season	P (mm)	0	14	64.6	100.6	4	5.4	50	21.4	39	15.8	1.8	0	**316.6**
		AT (^{o}C)	17.6	12.3	5.4	-4.8	-5.7	-2.4	7.9	11.3	12.7	19.5	22.2	24.3	**10.0**
		RH (%)	41.4	59.9	77.3	83.5	84	77	56	54.2	42.4	47.8	42	41.2	**58.9**
	Long term (1990-2006)	P (mm)	18.4	24.4	34.7	50.5	30.8	34.9	44.4	53.7	47.5	23.9	17.5	14.6	**395.5**
		AT (^{o}C)	16.9	12.4	5.5	0.8	-1.4	-0.5	3.4	9.2	14.0	18.2	21.7	21.6	**10.1**
		RH (%)	67.9	73.3	78.7	81.6	79.1	78.5	77.7	75.9	73.0	68.9	63.3	63.1	**73.4**
Yenimahalle	2006-2007 season	P (mm)	78.3	37.1	19.0	1.3	39.0	16.4	37.5	23.8	17.9	31.7	3.9	9.8	**315.7**
		AT (^{o}C)	18.2	13.6	5.6	1.1	1.3	2.6	7.3	9.2	20.5	22.5	26.7	26.3	**12.9**
		RH (%)	58.0	70.2	71.2	62.8	76.1	68.3	59.5	53.6	41.1	39.4	29.9	37.1	**55.6**
	2007-2008 season	P (mm)	0.0	14.1	66.7	44.4	20.1	6.5	54.9	32.7	45.4	10.3	0.0	0.7	**295.8**
		AT (^{o}C)	20.8	14.5	6.9	2.3	-4.0	0.1	10.2	13.8	15.5	22.0	24.9	26.7	**12.8**
		RH (%)	35.2	56.4	73.3	75.3	74.8	67.9	57.6	54.7	51.1	41.2	35.7	34.7	**54.8**
	Long term (1975-2006)	P (mm)	15.0	30.6	37.0	42.7	40.1	33.4	36.0	52.3	49.0	32.2	15.6	12.3	**396.1**
		AT (^{o}C)	18.5	12.9	6.6	2.3	0.4	1.9	5.9	11.2	16.0	20.0	23.4	23.1	**11.8**
		RH (%)	51.1	61.2	70.5	76.5	73.7	70.7	64.0	60.9	57.9	53.4	47.9	47.6	**61.3**

(*) Anonymous, 2009c. The climatic data of Yenimahalle and Haymana . The General Director of State Meteorological, Annual Climatic Observation Table.

Long term average rainfall and temperatures are 396.1 mm and 11.8 ^{o} C at Yenimahalle (1975-2006), and 395.5 mm and 10.1 ^{o} C and Haymana (1990-2006) (Table 1).

Analysis of variance for all characters were performed for all data measured. The significance of the main effects was estimated by the F test. Differences among treatment means were detected by LSD test ($P < 0.05$).

Correlation analysis was performed for all the characters measured. Cluster analysis with Single Linkage Method and Correlation Coefficient Distance was applied to some group detected for traits in a cluster for easy selection of promising lines.

RESULTS AND DISCUSSIONS

Phenological Characters

There were no significant differences among the accessions in days to flowering time and to seed maturating time (Table 2). Flowering and seed maturity times changed through locations and years. The flowering times at Haymana location were longer than those at Yenimahalle location. Haymana location had longer and shorter seed maturity times

in the first and second trial season than Yenimahalle location did, respectively. These differences may be derived from the influence of daily temperature changes during the seed setting and maturity times.

Table 2. Days to flowering time and to seed maturating time for the accessions of Hungarian vetch

Accessions	Days to flowering time				Days to seed maturating time			
	Yenimahalle		Haymana		Yenimahalle		Haymana	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
L-1724 Line number 1	205	223	232	242	235	259	270	254
L- 1725 Line number 2	205	223	233	242	235	259	271	254
L- 1726 Line number 3	209	225	233	242	235	259	271	254
L- 1727 Line number 4	206	224	233	242	235	259	271	254
Check variety Tarmbeyazı98	207	224	233	242	235	259	271	254

Morphological Characters

There weren't significantly differences among the observed morphological characters, except stem numbers per main stem (SNMS) (Table 3). The values of seed numbers per pod (SNP), and pod length (PL) of the lines were higher than those of Tarmbeyazı-98. The averages of main stem length (MSL), natural plant height (NPH), and stem numbers per main stem (SNMS) in this trials were 40.4 cm, 34.24 cm, and 3.16 stem number, respectively. Orak et al. (2004) determined plant height (4.66-90.66 cm), and stem numbers per plant (2.50-6.00) for Hungarian vetch genotypes.

Green Herbage and Hay Yields

There weren't significantly differences among lines in green herbage and hay yields during two cropping seasons at Yenimahalle and Haymana locations, except hay yields of 2007-2008 season at Haymana (Table 4 and 5). The L-1724, and L-1727 lines at Haymana location and L-1726 line at Yenimahalle location gave higher green herbage and hay yields than Tarmbeyazı-98's yields.

Table 3. Two - year averages of morphological traits of Hungarian vetch lines and check variety at Haymana location

Lines	**MSH(*)**	**MSD(*)**	**NPL(*)**	**SNMS(*)**	**PNP(*)**	**SNP(*)**	**PL(*)**	**PW(*)**
L-1724	43.0	1.95	36.25	3.86 A	7.8	4.3	25.4	6.8
L- 1725	37.4	1.99	32.28	2.53 B	8.5	4.7	27.2	6.8
L- 1726	38.6	1.83	32.55	3.0 B	6.8	4.5	23.8	6.6
L- 1727	43.9	2.05	37.20	3.13 AB	7.2	4.3	24.6	6.4
Tarmbeyazı-98	39.3	2.05	32.90	3.26 AB	7.1	4.1	23.2	6.6
Averages	40.4	1.97	34.24	3.16	7.5	4.4	24.8	6.7
$F_{(0.05)}$	**1.8**	**0.98**	**1.80**	**3.41 ***	**1.03**	**0.82**	**1.35**	**0.19**
CV (%)	**12.9**	**11.38**	**12.29**	**20.23**	**21.10**	**15.88**	**13.38**	**12.92**
$LSD_{(0.05)}$	**6.40**	**0.27**	**5.15**	**0.78**	**1.93**	**0.85**	**4.07**	**1.05**

(*)MSL: Main stem length (cm)
(*)MSD: Main stem diameter (mm)
(*)NPH: Natural plant height (cm)
(*)SNMS: Stem numbers per main stem
(*)PNP: Pod numbers per plant
(*)SNP: Seed numbers per pod
(*)PL: Pod length (mm)
(*)PW: Pod weight (mm)

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

Table4. Green herbage yields (kg/ha) of the lines and check variety at Yenimahalle and Haymana

	Yenimahalle			**Haymana**			**Two location**
	2006-07	**2007-08**	**Averages**	**2006-07**	**2007-08**	**Averages**	**averages**
L-1724	5113.3	4650.0	4881.7	14144.4	3783.3	8963.9	6922.8
L- 1725	5526.7	3970.8	4748.8	11072.2	3958.3	7515.3	6132.0
L- 1726	5846.7	4666.7	5256.7	10966.7	3495.8	7231.3	6244.0
L- 1727	6226.7	3208.3	4717.5	12859.7	3683.3	8271.5	6494.5
Tarmbeyazı-98	5946.7	3533.3	4740.0	12547.2	2750.0	7648.6	6194.3
Average	5732.0	4005.8	4868.9	12318.1	3534.2	7926.1	6397.5
$F_{(0.05)}$	1.38	1.53	0.49	1.46	3.72	1.52	0.80
CV (%)	10.97	22.82	16.11	15.42	11.92	17.36	19.61
$LSD_{(0.05)}$	1184.22	1721.32	960.36	3577.68	793.24	1684.41	1037.29
$F_{(0.05)}$ (year)			36.29**			305.52**	262.95 **
$F_{(0.05)}$ (location)							88.99 **
$F_{(0.05)}$ (year x variety)			2.47			1.61	1.50
$F_{(0.05)}$ (location x variety)							1.22
$F_{(0.05)}$ (location x year)							118.57 **
$F_{(0.05)}$ (location x variety x year)							1.40

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

Table 5. Hay yields (kg/ha) of the lines and check variety at Yenimahalle and Haymana

	Yenimahalle			Haymana			Two location
	2006-07	2007-08	Averages	2006-07	2007-08	Averages	averages
L-1724	1022.7	1328.7	1175.7	4407.1	1036.4 A	2721.7	1948.7
L- 1725	1105.3	1119.7	1112.5	3581.8	1007.1 A	2294.4	1703.5
L- 1726	1169.3	1351.2	1260.3	3290.0	914.0 A	2102.0	1681.1
L- 1727	1245.3	881.6	1063.4	4380.1	949.2 A	2664.6	1864.0
Tarmbeyazı-98	1189.3	970.0	1079.7	3832.4	730.0 B	2281.2	1680.4
Average	1146.4	1130.2	1138.3	3898.3	927.3	2412.8	1775.6
$F_{(0.05)}$	1.38	2.63	1.18	1.86	6.52 *	2.18	1.35
CV (%)	10.97	19.8	15.94	15.97	8.79	18.39	20.70
LSD $_{(0.05)}$	236.84	421.34	222.17	1172.0	153.55	543.31	303.82
$F_{(0.05)}$ (year)			0.05			335.93**	247.58 **
F $_{(0.05)}$ (location)							180.27 **
F $_{(0.05)}$ (year x variety)			3.48*			1.71	2.19
$F_{(0.05)}$ (location x variety)							2.11
$F_{(0.05)}$ (location x year)							242.24 **
$F_{(0.05)}$ (location x variety x year)							1.15

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

Table 6. Biological yields (kg/ha) of the lines and check variety at Yenimahalle and Haymana

	Yenimahalle			Haymana			Two location
	2006-07	2007-08	Averages	2006-07	2007-08	Averages	averages
L-1724	2293.3	1729.2	2011.3	3787.5	2329.2	3058.3	2534.8
L- 1725	2483.3	1979.2	2231.3	3125.0	2654.2	2889.6	2560.4
L- 1726	2326.7	1583.3	1955.0	2966.7	2418.8	2692.7	2323.9
L- 1727	2440.0	1337.5	1888.8	3467.5	2508.3	2987.9	2438.3
Tarmbeyazı-98	2690.0	1733.3	2211.7	2575.0	2579.2	2577.1	2394.4
Average	**2446.7**	**1672.5**	**2059.6**	**3184.3**	**2497.9**	**2841.1**	**2450.4**
$F_{(0.05)}$	1.25	1.41	**1.55**	1.26	0.39	0.76	**0.46**
CV (%)	10.47	20.46	**14.68**	22.46	**14.22**	19.87	**20.41**
LSD $_{(0.05)}$	482.47	644.49	**370.05**	1346.91	**668.84**	691.23	**413.51**
$F_{(0.05)}$ (year)			**49.17****			11.07**	**31.95 ****
F $_{(0.05)}$ (location)							**36.59 ****
F $_{(0.05)}$ (year x variety)			**1.06**			1.42	**1.09**
$F_{(0.05)}$ (location x variety)							**1.45**
$F_{(0.05)}$ (location x year)							**0.11**
$F_{(0.05)}$ (location x variety x year)							**1.30**

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

According to the results of combined analysis of two locations data, the average yields of green herbage and hay of the lines weren't also significantly different from that of the check variety, but the lines of L-1724, and L-1727 had significantly higher green herbage and hay yields than Tarmbeyazı-98's yields at two locations. The green herbage and hay yield averages at Haymana and Yenimahalle locations were significantly influenced by year impact, except hay yield averages at Yenimahalle.

Two location averages of green herbage and hay yields were significantly changed through year and location impacts. Only the interactions of year x location of green herbage and hay yields were found significantly different at 1 % level.

Green herbage and hay yield averages at Haymana were higher than those at Yenimahalle. As a result, Haymana location was favorable for the hay production with regard to climatic factors. Amount of rainfall and average temperature during the same period (from 01 March to 30 June) were 122.0 mm and 14.0 ^{o} C; 107.6 mm and 12.75 ^{o} C at Yenimahalle and Haymana, respectively. Orak and Tuna (1994) reported the highest green herbage yield as 2828.52 kg/ha under the conditions of Thrace Region. Orak and Nizam (2003) obtained the highest green herbage and hay yields as 1813.66 kg/ha and 535.04 kg/ha, respectively under the same ecological conditions. Ünver et al. (2000) detected that green herbage and hay yield averages ranged from 1578.33 to 2147.67 kg/ha and from

434.67 to 600.67 kg/ha, respectively. Yolcu et al. (2009) measured that green herbage and hay yield averages ranged from 8354 to 8489 kg/ha and from 2350 to 3484 kg/ha, respectively. The yield values of this trials were higher than that of above mentioned trials, except the yields data of Yolcu et al (2009)'s. The main reasons for these large variation were attributed to differences among the climatic conditions and the growing periods of regions.

Biological and Seed Yields

There weren't significantly differences among lines in biological yields during two cropping seasons at two

locations (Table 6). - But there were significantly differences among lines in seed yields during the season of 2007-2008 at Yenimahalle location. Moreover, there were also significant differences among lines in seed yields during the season of 2006-2007, and at the averages of Haymana location (Table7).

Table 7. Seed yields (kg/ha) of the lines and check variety at Yenimahalle and Haymana

	Yenimahalle			Haymana			Two location
	2006-07	2007-08	Averages	2006-07	2007-08	Averages	averages
L-1724	360.0	316.6 A	338.3	992.5 AB	766.7	879.5 AB	608.9 AB
L- 1725	365.7	355.6 A	360.7	885.8 ABC	883.3	884.5 AB	622.6 AB
L- 1726	413.3	225.0 B	319.2	618.7 C	625.0	621.8 C	470.5 C
L- 1727	385.0	361.0 A	373.0	1156.2 A	816.7	986.4 A	679.7 A
Tarmbeyazı-98	450.0	308.3 A	379.2	712.5 BC	766.7	739.5 BC	559.3 BC
Average	**394.8**	**313.3**	**354.1**	**873.2**	**771.7**	**822.4**	**588.2**
$F_{(0.05)}$	0.41	7.20**	0.66	4.60*	1.55	5.12**	5.33**
CV (%)	25.26	11.23	21.12	19.88	17.07	18.73	20.02
LSD $_{(0.05)}$	187.81	66.29	91.54	326.93	248.03	188.63	97.33
$F_{(0.05)}$ (year)			8.89**			3.25	9.05 **
F $_{(0.05)}$ (location)							237.22 **
F $_{(0.05)}$ (year x variety)			1.66			1.85	1.05
$F_{(0.05)}$ (location x variety)							3.70 *
$F_{(0.05)}$ (location x year)							0.10
$F_{(0.05)}$ (location x variety x year)							2.80 *

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

Table 8. Harvest index (%) of the lines and check variety at Yenimahalle and Haymana

	Yenimahalle			Haymana			Two location
	2006-07	2007-08	Averages	2006-07	2007-08	Averages	averages
L-1724	15.8	18.7	17.2	26.5	32.7 A	29.6	23.4 B
L- 1725	14.7	17.9	16.3	28.3	33.2 A	30.7	23.5 AB
L- 1726	18.1	14.8	16.5	22.4	25.8 B	24.1	20.2 B
L- 1727	15.8	27.9	21.8	34.0	32.6 A	33.3	27.5 A
Tarmbeyazı-98	16.3	17.8	17.0	31.4	29.8 AB	30.6	23.8 AB
Average	**16.2**	**19.4**	**17.8**	**28.5**	**30.8**	**29.7**	**23.7**
$F_{(0.05)}$	0.27	5.93	2.12	0.94	4.91*	1.98	2.85 *
CV (%)	25.73	18.08	21.63	28.15	7.89	19.99	22.35
LSD $_{(0.05)}$	7.82	6.61	4.70	15.11	4.58	7.25	4.38
$F_{(0.05)}$ (year)			5.41*			1.97	4.15 *
F $_{(0.05)}$ (location)							75.26 **
F $_{(0.05)}$ (year x variety)			3.13*			0.56	0.71
$F_{(0.05)}$ (location x variety)							0.74
$F_{(0.05)}$ (location x year)							0.12
$F_{(0.05)}$ (location x variety x year)							0.64

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

Biological yield averages of lines and check variety varied between 1888.8 kg/ha and 2231.3 kg/ha; 2577.1 kg/ha, and 3058.3 kg/ha, respectively at the locations of Yenimahalle and Haymana. Seed yield averages of lines and check variety ranked from 319.2 kg/ha to 379.2 kg/ha; from 621.8 kg/ha to 986.4 kg/ha, respectively at the locations of Yenimahalle and Haymana. The line of L-1727 gave the highest seed yield of all lines as 986.4 kg/ha and 679.7 kg/ha at Haymana and two location averages, respectively.

The biological yield averages at Haymana and Yenimahalle locations were significantly found by year effect. Two location averages of biological yield were significantly changed through year and location effects. There weren't statistically significant found on the whole interactions of biological yields.

The influence of year showed significantly differences among the seed yields at Yenimahalle location, but it didn't at Haymana location. Two location averages of seed yield were significantly changed through year and location effects. There were found significantly differences of the interactions of location x variety and location x variety x year in the seed yield averages at two locations.

Table 9. Correlation coefficients of the traits observed at Haymana trials

	MSL	MSD	NPH	SNMS	PNP	SNP	PL	PW	GHY	HY	BY	SY
MSL	1.000											
MSD	-0.026	1.000										
NPH	0.953**	-0.135	1.000									
SNMS	0.167	0.134	0.188	1.000								
PNP	-0.371*	0.475**	-0.513**	-0.217	1.000							
SNP	-0.338	0.400*	-0.484**	-0.293	0.807**	1.000						
PL	-0.628**	0.101	-0.639**	-0.195	0.504**	0.501**	1.000					
PW	0.272	0.242	0.232	-0.205	0.126	0.210	-0.282	1.000				
GHY	0.785**	-0.139	0.879**	0.354	-0.610**	-0.613**	-0.662**	0.251	1.000			
HY	0.675**	-0.255	0.807**	0.280	-0.725**	-0.708**	-0.601**	0.084	0.926**	1.000		
BY	0.786**	-0.015	0.806**	0.118	-0.300	-0.389*	-0.425*	0.285	0.766**	0.662**	1.000	
SY	0.481**	0.002	0.461 *	-0.086	-0.063	-0.177	0.014	0.022	0.324	0.400*	0.603**	1.000

MSL: Main stem length (cm)
MSD: Main stem diameter (mm)
NPH: Natural plant height (cm)
SNMS: Stem numbers in main stem
PNP: Pod numbers in a plant
SNP: Seed numbers in a pod
PL: Pod length (cm)
PW: Pod wide (mm)
GHY: Green herbage yield (kg/ha)
HY: Hay yield (kg/ha)
BY: Biological yield (kg/ha)
SY: Seed yield (kg/ha)
* significant at $P \leq 0.05$, **) significant at $P \leq 0.01$

Haymana location gave higher biological and seed yield averages than Yenimahalle location did. These distinctions may be resulted from the differences in climatic factors such as temperature and rainfall. As a result, Haymana location is more favorable for the seed production than Yenimahalle location. Uzun et al. 2004 reported that the biological and the seed yield of Hungarian vetch as 5199.0- 6070.0 kg/ha and 973- 1036 kg/ha, respectively. Orak and Nizam (2003) detected the highest seed yield as 972.9 kg/ha.

Harvest Index

There were significantly differences among lines in harvest index at two locations averages, and during the season of 2007-2008 at Haymana location (Table 8).

The line of L-1727 had the highest harvest index compared to the other materials at the locations. Haymana location had higher harvest index than Yenimahalle did, because of its high seed yield. Two location averages ranged from 20.2 % to 27.5 %.

Harvest index values at Yenimahalle location were significantly effected through year effect, but those at Haymana location weren't. Two location averages in harvest index were significantly changed by year and location impacts. Only year x variety interaction was significantly found, but the other interactions weren't.

Correlation Coefficients

There were statistically positive significant correlations ($P<0.01$) with hay yield (HY) and main stem length (MSL), natural plant height (NPH), green herbage yield (GHY), but it had negative significant correlations with ($P<0.01$) pod numbers per plant (PNP), seed numbers per plant (SNP), pod length (PL) (Table 9). The seed yield (SY) had statistically positive significant correlations ($P<0.01$ and $P < 0.05$) with main stem length (MSL), biological yield (BY), natural plant height (NPH), and hay yield (HY). These relationships among the characters will be useful for selection of desired traits and promising accessions.

Cluster Analysis

Cluster analysis was applied to group some of the plant traits (Table 10 and Figure1). The traits observed and their groups can be easily seen in a dendrogram (Figure 1). There were four groups on traits of Hungarian vetch lines. The four groups consisted of six, one, one, and four traits. The first group contained following traits MSL, NPH, GHY, HY, BY and SY. The second and third groups included in SNMS and PW, respectively. The fourth group covered MSD, PNP, SNP and PL.

Table 10. Clustering history of some traits on Hungarian vetch accessions

Step	Number of clusters	Cluster joined	Similarity level	Distance level
1	11	1-3	97.67	0.047
2	10	9-10	96.31	0.074
3	9	1-9	93.97	0.121
4	8	5-6	90.37	0.193
5	7	1-11	90.31	0.194
6	6	1-12	80.17	0.397
7	5	5-7	75.19	0.496
8	4	2-5	73.73	0.525
9	3	1-4	67.72	0.646
10	2	1-8	64.24	0.715
11	1	1-2	62.10	0.758

There were the highest similarity (97.67) and the nearest distance (0.047) levels between MSL and NPH in the first group and figure 1. At the same group, the lowest similarity (80.17) and the further distance (0.397) levels were detected between MSL and SY.

In figure 1, the lowest similarity (62.10) and the furthest distance (0.758) levels were found between MSL and MSD.

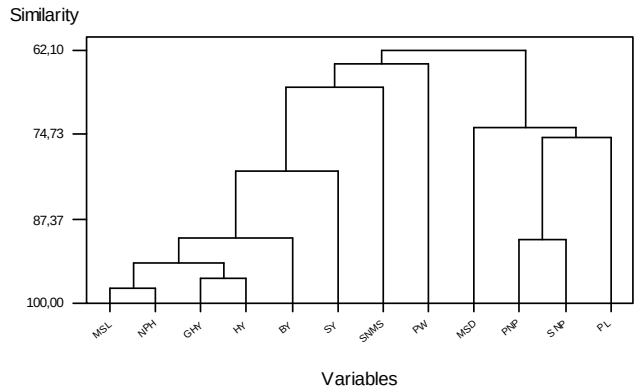

Figure 1. Dendrogram of hierarchical clustering of some traits on Hungarian vetch accessions

Desired characters and their relationships with the others were correctly and easily determined in this study. If selected line possesses high hay yield, it is high green herbage, seed and biological yields. Consequently, only key traits such as hay and seed yields should be regarded instead of the observation of all traits.

Hay Quality

Some hay quality values of the lines and check variety at Haymana location are shown in the Table 11. Technological analysis showed that there were statistically significant differences among the values of some traits of lines. For example, there were significant differences among the crude protein percentage ($P < 0.05$), crude cellulose ($P < 0.05$), nitrogen free extract ($P < 0.05$), and digestible crude protein ($P < 0.01$) of trial materials. Orak et al. (2004) reported that the rates of crude protein and crude cellulose were 18.05 % and 12.15 %, respectively. Ünver et al. (2000) explained that the average crude protein rates ranged from 13.80 % to 19.67 % . Yolcu et al. (2009) found the average crude protein contents as 17.66 % and 12.34 % in 2007 and 2008, respectively. The literature data were lower than these trials' values. These differences might be resulted from various application procedures and different ecological conditions.

Table 11. Hay quality values of the lines and check variety at Haymana location

Lines	Water (%)	Dry matter (%)	Crude protein (%)	Crude cellulose (%)	Crude oil (%)	Crude ash (%)	Digestible crude protein (%)	Nitrogen free extract (%)	Organic matter (%)
L-1724	5.61 AB*	94.38 BC	21.5 B	22.0 A	1.5 AB	13.2	14.0 C	36.1 A	81.1
L-1725	5.72 A	94.27 C	22.7 A	20.7 B	1.3 B	12.6	15.2 AB	36.9 A	81.6
L-1726	5.56 BC	94.43 AB	22.5 A	21.1 B	1.2 B	12.6	14.8 B	36.8 A	81.8
L-1727	5.56 BC	94.43 AB	22.9 A	21.1 B	1.3 AB	12.8	15.0 B	36.1 A	81.5
Tarmbeyazı-98	5.42 C	94.57 A	23.2 A	21.2 B	1.6 A	13.6	15.7 A	34.8 B	80.9
$F_{(0.05)}$	*	*	*	*	-	-	**	*	-
CV (%)	**1.45**	**0.09**	**1.97**	**1.73**	**12.17**	**4.39**	**2.34**	**1.64**	**0.7**
$LSD_{(0.05)}$	**0.15**	**0.15**	**0.83**	**0.69**	**0.322**	**1.07**	**0.66**	**1.12**	**1.08**

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

Table 12. Dry matter yields. crude protein yields. and digestible crude protein yields at Haymana location

Lines	Dry matter yields (kg/ha)	Crude protein yields (kg/ha)	Digestible crude protein yields (kg/ha)
L-1724	978.3 A	223.4 A	146.0 A
L- 1725	949.3 A	228.7 A	153.5 A
L- 1726	863.1 A	206.0 AB	135.9 AB
L- 1727	896.3 A	217.4 A	142.8 A
Tarmbeyazı-98	690.4 B	169.6 B	115.3 B
Averages	**875.5**	**209.0**	**138.7**
$F_{(0.05)}$	**6.47 ***	**4.27 ***	**3.46**
CV (%)	**8.76**	**9.46**	**9.74**
$LSD_{(0.05)}$	**144.50**	**37.22**	**25.45**

* Means with the same letter in a column not statistically significant different from each according to the LSD test at $P \leq 0.05$

There were significantly differences among dry matter yields ($P < 0.05$) and crude protein yields ($P < 0.05$) of the lines at Haymana location (Table 12). Dry matter yield averages and Tarmbeyazı-98 values were 875.5, and 690.4 kg/ha, respectively. Crude protein yield averages and check variety values were 209. 0, and 169.6 kg/ha, respectively. Yolcu et al. (2009) determined that crude protein yields ranged from 415 to 425 kg/ha. These differences can be resulted from differences in ecological conditions. Digestible crude protein yield averages and Tarmbeyazı-98 values were 138.7, and 115.3 kg/ha, respectively. All lines gave higher values of dry matter, crude protein and digestible crude protein yield than Tarmbeyazı-98. In conclusion, three advanced lines (L-1724, L-1725, and L-1727) were selected because of having high yield, good quality, and adaptability in this regional trial and suggested for variety registration.

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