



Determination of Yield and Some Characteristics of Forage Pea Genotypes (*Pisum sativum* ssp. *arvense* L.) under Erzurum Conditions

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doi: 10.17097/ataunizfd.628404

Geliş Tarihi (Received): 02.10.2019 Kabul Tarihi (Accepted): 18.04.2020 Yayın Tarihi (Published): 19.05.2020

ABSTRACT: This research was planned to determine the performance of some forage pea (*Pisum sativum* ssp. *arvense* L.) genotypes in Erzurum conditions. The study was carried out in the Pasinler Research Station trial areas of the Eastern Anatolia Agricultural Research Institute in 2011, 2012 and 2013. Field experiments were conducted in randomized complete blocks design with 3 replications. According to the three-year averages; time for flowering was 55.0-62.8 days, time for physiological maturity was 91.6-102.0 days, plant height is 90.3-110.6 cm, green forage yield was 1587.8-2764.5 kg da⁻¹ and seed yield was 145.6-322.0 kg da⁻¹. The highest yield values were determined as 3156 kg da⁻¹ for green forage yield and 283.3 kg da⁻¹ for seed yield in the second year of the experiment and it was determined that there were significant differences between years and genotypes in terms of yield and agricultural characteristics. According to the correlation analysis between yield and yield components; a positive correlation was determined between green forage yield and the number of emergence days, plant height and number of branches, 1% pod number in the plant and 5% significance level, 1% between seed yield and thousand grain weight, 5% significance level in the number of pods. As a result, it is concluded that ecological properties affect yields and different genotypes have different yield potentials. It has been decided that H-13 and H-9 genotypes can be grown in the region without any problems in terms of green forage and seed yield. Among the varieties, because their seeds are easy find, Taskent, Tore, Urunlu and Ozkaynak varieties can be recommended for hay production and Kirazlı variety for seed production.

Keywords: Forage pea, Green forage yield, Seed yield, Genotype, Correlation

Erzurum Şartlarında Yem Bezelyesi (*Pisum sativum* ssp. *arvense* L.) Genotiplerinin Verim ve Bazı Özellikleri

ÖZ: Bu araştırma bazı yem bezelyesi (*Pisum sativum* ssp. *arvense* L.) genotiplerinin Erzurum koşullarındaki performanslarının belirlenmesi amacıyla planlanmıştır. Araştırma Doğu Anadolu Tarımsal Araştırma Enstitüsüne bağlı Pasinler Araştırma İstasyonu deneme alanlarında 2011, 2012 ve 2013 yıllarında yürütülmüştür. Araştırmada denemeler tesadüf blokları deneme desenine göre 3 tekerrürlü olarak kurulmuştur. Üç yıllık ortalamalara göre; çiçeklenme için geçen süre 55.0-62.8 gün, fizyolojik olgunluk için geçen süre 91.6-102.0 gün, bitki boyu 90.3-110.6 cm, yeşil ot verimi 1587.8-2764.5 kg da⁻¹ ve tohum verimi 145.6-322.0 kg da⁻¹ arasında değişmiştir. En yüksek verim değerleri denemenin ikinci yılında yeşil ot verimi için 3156 kg da⁻¹ ve tohum verimi için 283.3 kg da⁻¹ olarak tespit edilmiş, verim ve tarımsal özellikler bakımından yıllar ve genotipler arasında önemli farklılıklar olduğu belirlenmiştir. Verim ve verim unsurları arasında yapılan korelasyon analizine göre; yeşil ot verimi ile çıkış gün sayısı, bitki boyu ve yan dal sayısı arasında %1 bitkide bakla sayısı ile %5 önem seviyesinde pozitif, tohum verimi ile bin tane ağırlığı arasında %1, baklada tane sayısı ile %5 önem seviyesinde pozitif bir ilişki belirlenmiştir. Sonuç olarak ekolojik özelliklerin verimi oldukça etkilediği ve farklı genotiplerin farklı verim potansiyelleri olduğu kanaatine varılmıştır. Yeşil ot ve tohum verimi açısından H-9 ve H-13 genotiplerinin yörede sorunsuzca yetiştirilebileceği kararına varılmıştır. Çeşitler arasında ise tohumu kolay bulunmasından dolayı yeşil ot üretimi için Taşkent, Töre, Ürünlu ve Özkaynak çeşitleri; tohum üretimi için Kirazlı çeşidi önerilebilir.

Anahtar Kelimeler: Yem bezelyesi, Yeşil ot verimi, Tohum verimi, Genotip, Korelasyon

INTRODUCTION

Forage pea in Northeast Anatolia, especially in Kars, Ardahan and Bayburt is a plant that has been cultivated for many years both for its forage and for its grains in animal nutrition (Ozbek, 1980). It is known as külür or gügül in Erzurum, is suitable for

the ecology of the region due to its extremely cool and low temperature resistance. The hay, grain and straw of the forage pea are the source of food and energy for livestock. Its nutritional value is high and it is delicious. Forage pea with a very high crude

Bu makaleye atıfta bulunmak için / To cite this article: Kadioğlu, S., Tan, M., Kadioğlu, B., Taşğın, G., 2020. Determination of Yield and Some Characteristics of Forage Pea Genotypes (*Pisum sativum* ssp. *arvense* L.) under Erzurum Conditions. Atatürk Üniv. Ziraat Fak. Derg., 51 (2): 151-158. doi: 10.17097/ataunizfd.628404

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protein content (about 17-21%) can give about 1-4 tonnes of fresh forage per decare under favorable conditions (Ozkaynak 1980; Acikgoz 2001). Additionally forage pea enriches the soil with organic matter and nitrogen; it can also provide quality hay for animals in early spring with its winter resistance. Forage pea grains are an alternative plant that can be used instead of barley and vetch in animal feeding (Kadioglu et al., 2006). Because of the outstanding features of forage pea, in recent decades, a great deal of effort has been spent by many researches in Turkey to improve new high-yielding cultivars by using local or introduced forage pea materials (Bilgili and Acikgöz, 1999; Tekeli and Ates, 2003; Sayar and Anlarsal, 2008; Tan et al., 2012; Sayar and Han, 2016; Keskin and Temel, 2018). In order to ensure the return to forage pea farming and increase its cultivation, it is necessary to develop varieties suitable for the ecology of the region and grow superior genotypes by identifying some superior agronomic characteristics (Tan et al. 2012). In this study, the importance of forage pea is emphasized and some agricultural and phenological characteristics (days to emergence, flowering and ripening, plant height,

sub-branch number and pod number per plant, grain number per pod, thousand kernel weight, green forage and seed yield) were evaluated.

MATERIAL AND METHOD

The research was carried out in the Eastern Anatolia Agricultural Research Institute in Pasinler experiment area through spring cultivation for 3 years (2011, 2012 and 2013). In the study, totally, 18 forage pea genotypes were used as the plant materials. 8 of the genotypes were forage pea lines, supplied from Uludag University, Bursa, Turkey. The lines were found promising as result of breeding studies. In addition, 3 local forage pea varieties, Hınıs (Erzurum), Samsun, Ardahan and 5 registered forage pea cultivars, Tore, Taskent, Urunlu, Kirazli and Ozkaynak were used.

Climatic data is submitted in the Table 1. When Table 1 examined; the temperature values of 2013 were similar to the average of long years (1954-2010), the rainfall was low. The average temperatures in 2011 and 2012 also displayed values close to the long years averages, on the other hand, the rainfall amount of the growing years were found quite low than the rainfall amount of long years average (TUMAS, 2019; Table 1).

Table 1. Some meteorological data of trial years

Years	April	May	June	July	August	September
Temperature (⁰ C)						
1954-2010	5.3	10.6	14.9	19.3	19.3	14.5
2011	6.3	10.7	16.2	19.7	19.9	17.3
2012	5.9	10.1	15.0	19.4	19.0	13.9
2013	7.2	11.6	16.0	18.8	20.4	15.1
Rainfall (mm)						
1954-2010	52.2	68.5	47.4	25.8	16.3	22.2
2011	15.2	56.7	24.0	20.0	7.5	12.0
2012	16.0	47.5	29.0	10.0	15.0	16.0
2013	45.0	32.0	26.5	7.5	6.0	72.0

According to the analysis results of soil samples taken from 0-20 cm soil layer from the experiment area; the soil is loamy, slightly alkaline, salt-free,

calcareous, medium in phosphorus and rich in potassium, and poor in organic matter (Table 2).

Table 2. Analysis results of soil samples belonging to trial areas

Saturation	pH	EC	Salt %	Loam %	Organic matter %	P ₂ O ₅ kg da ⁻¹	K ₂ O kg da ⁻¹
40	7.56	2.16	0.06	1.96	1.38	5.40	92

The field experiments were designed according to the complete randomized blocks experiment design with three replications. Planting was made in 5 rows in 5 m length with 35 cm row spacing in the range of 100 plants per square meter in the last weeks of April. During sowing, 4 kg N da⁻¹ and 5 kg P₂O₅

da⁻¹ fertilizer were applied in the parcels (Kadioglu, 2015; Tan, 2018). In general, irrigations were applied before flowering, during flowering and in the bean filling period. After each irrigation, the growing weeds were removed by hoeing. Half of the plots were harvested for forage yield determining at the

blooming periods of the genotypes and the rest half was harvested for seed yield determining. 50 cm portions from the two rows at the sides and the two ends of the rows were taken as edge effects and neglected. Harvesting was performed on a total area of 4.2 square meters.

Bruchus spraying was carried out at a dose of 40 cc da⁻¹ with Deltamethrin effective drug before the formation of pods. Forage harvests were made when the grains were seen as projected in the pods, and seed harvests were carried out in the period in which the majority of the pods matured. The duration of flowering was taken as the date when there was 10% flowering in the parcels and the duration of physiological development was determined according to the date of seed harvest. The obtained data were analyzed by means of variance analysis in JUMP statistical package program and the means were compared with LSD test. Correlation analysis was conducted between the yield and the factors affecting the yield.

RESULTS AND DISCUSSION

Emergence, flowering and forage harvest days: Observation results vary considerably over the years in the study. The emergence period changes from 15.2 to 18.4 days with an average of 16.8 days. Depending on the emergence, the number of days of flowering onset (10% flowering) varied approximately between 55.2-60.3 days and the average was determined as 58.4 days. In another study conducted in Erzurum, it was stated that the number of flowering days was between 59-77 days (Gunduz, 2013). The number of flowering days in 2011-2013 was 60.3 days and in 2012 it was 55.2 days. While forage harvesting period ranged from 65.5 to 77.5 days for the same region, Tan et al. (2013) determined the weed harvesting period as 79-91 days. Emergence and flowering were significant at 1% in years and genotypes, while year, genotype and year x genotype interaction were significant at 1% level in weed harvest days. Although the course of temperature during the development period is suitable for long years average, rainfall was not regular and slow and it was above the average for many years until March, and below the average until the end of September for many years, so the temperature was effective in flowering and harvest (Table 1).

Number of sub-branches and plant height: Number of sub-branches is an important parameter especially in forage type peas. In the study, the number of sub-branches of varieties varied between 1.8-2.9. The average sub-branch development, which was 2.36 was around 2.77 in 2013. It can be stated that precipitation and temperatures have an effect on

this development as well as genotype differences. The average plant height of 92.8 cm was 103.6 cm in 2011 which was the highest height measurement, and according to mean of years the genotype Kirazli was 110.6 cm and H-2 was 108.9 cm (Table 3). The length of the forage pea varies from dwarf types that are as short as 20 cm and do not require any support to pole forms that grow more than 200 cm (Koivisto et al., 2002). In some studies, the plant height of forage peas were determined to be vary between 34.0-169.9 cm (Bilgili, 1997; Timuragaoglu et al. 2004; Ceyhan et al. 2005; Tamkoc, 2007; Oz and Karasu, 2010 and Kadioğlu, 2015).

Green forage yield: In the study, 1364.0 kg da⁻¹, 3156.0 kg da⁻¹ and 2590.2 kg da⁻¹ green forage yields were determined in 2011, 2012 and 2013, respectively. Year, genotype and year x genotype interaction were found to be significant at 1% (Table 3). In similar studies, green forage yield was found between 1156-4590 kg da⁻¹ (Uzun et al. 2005; Sayar et al., 2009).

Number of physiological mature days: Seed harvest was determined as 98 days on average (Table 4). According to the genotypes, seeds were harvested between 91.6-102.0 days. Year, genotype and year x genotype interaction were found significant at 1% according to the values of number of physiological development days. During the development period, forage pea, which does not like high temperature, requires humid and a cool environment. Therefore, during the development period, whereas the course of temperature goes in line with the average of long years, although the precipitation was not regular and slow, it was above the average of long years until March and below the average of long years until the end of September, thus the temperature was effective in maturation (Table 1; Table 4).

Number of pods per plant and number of grains in pods: In the study, while the average number of pods per plant was 8.1, the values were recorded between 5.9-10.4. The highest number of pods was in Taskent (Table 4). In similar studies, the number of pods in pea varieties were determined to vary between 6-14 (Gülümser et al., 1994), 36-60 (Qasim et al., 2001), 4.2-8.8 (Seyis, 1994), 26 (Karayel and Bozoğlu, 2008), 6.5-10 (Sayar et al., 2009), 7-25 units (Kılınç, 2017). Number of grains in pods is one of the important features that are considered as quality criteria in seed production affecting the yield and grain size. In the study, whereas the average number of pods per plant was 6.2, the values ranging between 5.4-7.5 were determined (Table 4).

Thousand grain weight: Values related to 1000-grain weight of genotypes, genotype, year and year x genotype interaction were found to be very important (Table 4). The average reached 202.8 g in 2011, 254.6 g in 2012 and 254.4 g in 2013. It has been recorded that whereas thousand grain weight takes value between 50-300 g in several studies

(Bauder, 1999; Ceyhan et al., 2005; Sayar et al., 2009; Yilmaz, 2010; Uzun et al., 2012). These recorded values are very similar to the results of the research. Different thousand grain weight values recorded may be due to the meteorological and ecological characteristics of the study area, especially the genetic material difference.

Table 3. Values of green forage yield and some properties of forage pea genotypes

Genotypes	Days of emergence (number)	Days of flowering (number)	Sub-branches (number)	Plant height (cm)	Days of green forage harvest (number)	Green forage yield (kg da ⁻¹)
Hınıs	16.0 F	58.3 C	2.6 A-D	92.2 EF	75.3 A	2638.0 A-D
Taşkent	17.8 AB	58.0 CD	2.9 A	93.4 D-F	70.8 E	2568.1 B-D
Ardahan	17.3 A-D	57.6 C-E	2.3 C-E	90.3 F	73.9 A-C	1645.4 F
Töre	16.0 F	62.1 A	2.9 A	103.4 BC	74.2 AB	2524.1 B-D
Samsun	16.3 D-F	62.8 A	2.0 F	91.5 EF	75.6 A	2698.5 AB
H6	16.1 EF	58.6 C	2.6 A-C	79.7 G	74.8 AB	2670.4 A-C
H8	16.6 C-F	60.9 AB	2.4 B-D	97.3 C-E	73.4 A-D	2497.1 CD
H9	17.2 A-E	55.0 F	2.1 EF	76.4 G	64.8 G	2159.4 E
H10	16.1 EF	59.4 BC	2.3 C-E	76.9 G	71.4 DE	2271.7 E
H12	17.6 A-C	55.7 EF	2.5 B-D	108.9 AB	67.7 F	1587.8 F
H13	17.6 A-C	57.6 C-E	1.8 F	81.3 G	72.4 B-E	2764.5 A
H14	18.0 A	56.2 D-F	2.4 B-D	100.6 C	65.4 FG	2237.2 E
H15	16.8 B-F	58.3 C	2.4 B-D	92.2 EF	72.6 B-E	2472.0 D
Ürünlü	16.4 C-F	57.7 CD	2.6 AB	100.0 CD	71.7 C-E	2561.3 B-D
Özkaynak	17.1 A-F	58.6 C	2.4 B-D	90.5 EF	75.6 A	2518.5 B-D
Kirazlı	17.0 A-F	59.1 BC	2.3 DE	110.6 A	71.0 E	2107.6 E
Year	**	**	**	**	**	**
Genotype	**	**	**	**	**	**
Year x genotype	ns	*	**	**	**	**
CV (%)	7	3	13	7	3	10
LSD (0.05)	0.8	1.3	0.2	4.8	1.6	130
2011	15.2 C	60.3 A	2.16 B	103.6 A	68.6 B	1364.0 C
2012	16.8 B	55.2 B	2.25 B	98.4 B	68.9 B	3156.0 A
2013	18.4 A	59.9 A	2.77 A	76.3 C	78.1 A	2590.2 B

** 0.01, * 0.05, ns shows non-significant significance at the level. Means marked with different letters are statistically different from each other.

Seed yield: On average, seed yield was 223.0 kg da⁻¹. The highest seed yield was gained in 2012 (283.3 kg da⁻¹). Year, genotype and year x genotype interaction were found to be significant at 1% (Table 4). Similar results were obtained in similar studies. Under Samsun ecological conditions, Seyis (1994) has reported a seed yield in different pea varieties as in 78.6-154 kg da⁻¹, and Gulumser (2004) has stated seed yield in 158.4- 259.8 kg da⁻¹.

The minimum and maximum values of seed yield in the studies of Kaya (2000) was in 63.5-223.8 kg da⁻¹, of Togay et al. (2006) was in 82.5-86.3 kg da⁻¹, of Bozoglu et al. (2007) in 100.6-220.1 kg da⁻¹. Whereas a seed yield of in 113-163 kg da⁻¹ from forage pea varieties of Urunlu and Kirazli under Erzurum conditions has been taken (Kadioglu, 2019) Urunlu and Kirazli, a seed yield of in 300 kg da⁻¹

from the same varieties has been taken in Bursa conditions (Uzun et al., 2012). In another study carried out in Erzurum, 259-289 kg of seed per decare from Taskent and Ozkaynak in autumn sowing and 300 kg of seed yield has been recorded on H-10 and H-15 lines (Kadioglu and Tan, 2018). Therefore, sowing time, environmental conditions and genotype cause a significant difference in seed yield. Generative ripening and seed setting varies considerably depending on precipitation and temperature. In the summer period, the temperature was parallel to the long years, however the rainfall was below the average of long years (Table 1).

Although the temperature was suitable for the average of long years, precipitation was not slow. This negatively affected the plant during the full seed formation period. As it is known, climatic factors (temperature and rainfall) play a major role on seed

filling time. Low temperature, high proportional humidity and short day length delays the physiological maturity and leads to a decrease in efficiency (Bilgili, 2009). Seed yield generally depends on the number of plants per unit area, the number of pods per plant and the number of grains per pod (Table 4). Therefore, it has been reported that plants that produce more seeds per plant may have more seed yield (Elci and Orak, 1991; Oz and Karasu, 2010) and years also have significant impact

on seed yield (Onder and Ceyhan, 2001; Acikgoz et al., 2007). The irregularity and instability of the distribution of temperature and precipitation during the year affected all elements, while the highest seed yield was obtained in the second year, high temperatures and inadequate rainfall caused drought and hot stress in the third year, thus shortening of the grain filling time and as a result low yield was obtained.

Table 4. Values of seed yield and some yield components of forage pea genotypes

Genotypes	Pods per plant (number)	Grain per pods (number)	Physiological mature days (number)	Thousand grain weight (g)	Seed yield (kg da ⁻¹)
Hınıs	8.5 CD	6.4 DE	99.1 BC	196.4 H	145.6 L
Taşkent	10.4 A	6.6 B-D	93.8 EF	198.4 H	223.1 F
Ardahan	8.8 C	6.5 C-E	92.7 EF	159.5 J	183.6 K
Töre	8.3 C-E	7.2 A	102.0 A	185.0 I	187.0 K
Samsun	8.9 BC	7.5 A	100.2 AB	283.7 BC	220.3 FG
H6	8.3 C-E	6.3 DE	99.2 BC	276.8 CD	193.5 JK
H8	7.1 E-G	7.2 A	99.0 BC	303.4 A	211.1 GH
H9	9.4 A-C	7.0 A-C	91.6 F	241.3 F	322.0 A
H10	5.9 G	6.0 EF	102.0 A	273.9 D	204.3 HI
H12	8.4 CD	6.1 D-F	94.6 DE	241.8 F	212.0 GH
H13	7.3 D-F	7.1 AB	99.1 BC	287.2 B	184.2 K
H14	8.5 CD	6.2 DE	96.9 CD	271.0 D	234.3 E
H15	7.4 D-F	5.4 G	99.2 BC	258.7 E	199.1 IJ
Ürünlü	7.0 FG	5.6 FG	100.1 AB	209.8 G	250.4 D
Özkaynak	10.1 AB	7.1 AB	100.3 AB	199.3 H	292.6 C
Kirazlı	5.9 G	6.1 D-F	98.6 BC	210.9 G	305.1 B
Year	**	**	**	**	**
Genotype	**	**	**	**	**
Year x genotype	**	**	**	**	**
CV (%)	11	9	2	3	8
LSD (0.05)	0.9	0.3	0.8	5.0	7.5
2011	7.2 B	6.9 A	95.6 B	202.8 B	225.6 B
2012	8.5 A	6.9 A	93.6 C	254.6 A	283.3 A
2013	8.7 A	5.7 B	104.7 A	254.4 A	160.0 C

**0.01, * 0.05, shows significance at the level. Means marked with different letters are statistically different from each other.

When the correlation table of the investigated properties was created (Table 5); there is a positive correlation between green forage yield and number of emergence days, plant length and number of sub-branches at 1% significance level, and the number of pods per plant at 5% level of significance. The sub-branches, leaves and leaflets may also increase with the plant height, forage yield also increases (Anlarsal and Gulcan, 1989). There is a positive correlation between seed yield and thousand seed weight 1%

significance level, and a positive correlation between seed yield and grain number per pod at 5% significance level.

The relationship between seed yield and seed number per pod shows that the direct effect of grain number of per pod on grain yield is slightly felt, and this result is consistent with some studies (Acikgoz et al., 2007; Gurbuz et al., 2004). The presence of positive or negative relationships, which are

significant at the 1% and 5% significance levels, is important for the determination of selection criteria.

The relationship between these characteristics and yields is not different from the criteria obtained in breeding studies (Erman et al., 1997; Albayrak, 2004).

Table 5. Correlation values between yield and some yield components

	GFY	SY	TGW	NDE	NFD	NPMD	NPP	NGP	PH	NGHD	NSB
GFY	1.000										
SY	0.076	1.000									
TGW	-0.144	0.436**	1.000								
NDE	0.341**	-0.197	0.317**	1.000							
NDF	-0.354	-0.422	-0.197	-0.170	1.000						
NPMD	0.142	-0.381	0.203**	0.209**	0.319**	1.000					
NPP	0.179*	0.018	0.017	0.150	-0.200	-0.101	1.000				
NGP	-0.028	0.186*	-0.073	-0.244	-0.100	-0.356	0.190*	1.000			
PH	0.309**	-0.205	-0.447	-0.388	-0.027	-0.473	-0.177	0.146	1.000		
NGHD	0.110	-0.430	0.133	0.230**	0.445**	0.641**	0.153	-0.196	-0.505	1.000	
NSB	0.316**	-0.274	-0.023	0.252**	0.127	0.022	0.044	-0.370	-0.198	0.368**	1.000

GFY: Green forage yield, SY: Seed yield, TGW: Thousand grain weight, NDE: Number of days of emergence, NDF: Number of days of flowering, NPMD: Number of physiological mature days NPP: Number of pods per plants, NGP: Number of grains in pods, PH: Plant height, NWHD: Number of green grass harvest days, NSB: Number of sub-branches

CONCLUSIONS

One of the most important targets in forage crop culture is to increase the yield in the unit area. In order to develop suitable varieties that adapt to the region, it will be more accurate to determine the factors affecting the yield of hay and seed and to determine the relationships among these factors and to make the choices in breeding studies according to these elements. In this context, it can be said that forage yield is related to plant height and sub-branch number and the seed yield is related to plant height, number of ripening days and number of grains per pod and these elements will facilitate the selection.

As a result of this study, it can be stated that the H-9 and H-13 lines are suitable for both forage and seed production in the current conditions. However, due to the ease of seed supply in the short term, Taskent, Tore, Urunlu and Ozkaynak cultivars for forage production; Kirazlı variety for seed production can be recommended.

ACKNOWLEDGEMENT

This research was supported by funds of General Directorate of Agricultural Research and Policies (TAGEM) with the project number TBAD/12/A03/P01/005. We would also like to thank the TAGEM that supported the project.

Statement of Conflict of Interest

We declare that there are no conflicts of interest among the authors.

Authors' Contributions

SK, project design, establishment of field experiments, conducting other studies, statistical analysis, evaluation and writing of the article, MT, evaluation of the study and writing the article, BK, establishment of field experiments, following field studies, taking observations, conducting and evaluating soil analysis, GT, establishment experiments, following field studies and taking observations. All authors have read and approved the last article.

REFERENCES

- Acikgoz E., 2001. Forage Crops. Reprinted 3rd Edition. Uludag Univ. Foundation, Bursa. Publication No: 182, 584 p.
- Acikgoz, E., Ustun, A., Gul, I., Anlarsal., A.E., Tekeli, A.S., Nizam, I., Avcioglu, R., Geren, H., Cakmakci, S., Aydinoglu, B., Yucel, C., Avci, M., Acar, Z., Ayan, I., Uzun, A., Bilgili, U., Sincik, M., Yavuz, M., 2007. Pea (*Pisum sativum* L.) with genotype x environment interactions and stability analysis of seed yield and dry matter. Turkey 7. Agronomy Cong., Erzurum, pp. 79-82. (in Turkish)
- Anlarsal, A., Gulcan, H., 1989. Path analysis on forage yield and some important yield components in vetch (*V. sativa* L.) varieties under Cukurova conditions. Turkish Journal of Agriculture and Forestry, 13: 487-494. (in Turkish with abstract in English)
- Anlarsal, A.E., Yücel, C., Özveren, D., 2001. A research on the determination of their yields and

- adaptations of some pea lines in Cukurova conditions. Journal of Cukurova Univ. Faculty of Agriculture, 16(3): 11-20. (in Turkish with abstract in English)
- Albayrak, S., 2004. A study on the determination of seed yield-related characters in vetch (*Vicia sativa* L.) by correlation and path analysis. Journal of Field Crops Central Research Institute, 10 (1-2): 83-87. (in Turkish)
- Bauder, J., 1999. Pulse Crops That Do Well In Montana. Montana State Univ. Communications Services, USA, pp. 1-16.
- Bilgili, U., 1997. Researches on Important Morphological and Agricultural Properties in Close Isogenic Forage Pea Lines with Different Leaf Properties. Uludag University. Institute of Science, Field Crops Master Thesis, Bursa, 65 p. (in Turkish)
- Bilgili, U., Acikgoz, E., 1999. Researches on important morphological and agricultural characteristics of close isogenic forage pea lines with different leaf characteristics. 3. Turkey Field Crops Congress, 15-18 November, 1999, Adana, pp. 96-101. (in Turkish)
- Bilgili, U., 2009. Forage pea (*Pisum arvense* L.), Forage Crops, Volume: II, Ministry of Agriculture and Rural Affairs, General Directorate of Agricultural Production Development, Izmir, p. 440-447. (in Turkish)
- Bozoglu, H., Peksen, E., Peksen, A., Gulumser, A., 2007. Determination of the yield performance and harvesting periods of fifteen pea (*Pisum sativum* L.) cultivars sown in autumn and spring. Pakistan Journal of Botany, 39 (6): 2017-2025.
- Ceyhan, A., Avci, M.A., McPhee, K.E., 2005. Yield and some agricultural characteristics of pea genotypes grown in winter under Konya ecological conditions. Journal of Selcuk Univ. Agricultural Fac., 19: 6-12. (in Turkish with abstract in English)
- Elci, S., Orak, A., 1991. A research on the determination of common vetch lines that can adapt in Tekirdag conditions. Turkey 2. Grassland and Forage Crops Congress, May 28-31, Izmir, p: 540-551. (in Turkish)
- Erman, M., Ciftci, V., Gecit, H.H., 1997. A study on chickpea (*Cicer arietinum* L.) inter-feature relationships and path coefficient analysis. Journal of Agricultural Sciences, 3: 43-46. (in Turkish with abstract in English)
- Gulumser, A., Bozoglu, H., Peksen, E., Kahraman, A., 1994. A research on the detection of some faba bean varieties that can be grown in Samsun ecological conditions. Field Crops Congress, 25-29 April 1994, Volume I: Agronomy Papers, p: 250-253, Izmir. (in Turkish)
- Gulumser, A., 2004. Comparison of fresh pod yield and pod related characteristics in pea (*Pisum sativum* L.) cultivars sown in autumn and spring under Samsun ecological conditions. Turkish Journal of Agriculture and Forestry, 28: 363-370.
- Gunduz, H., 2013. Some Morphological and Agricultural Properties of Forage Pea Lines Selected from the Northeastern Anatolia Region Population. Ataturk University Institute of Science, Master Thesis, Erzurum, 46 p. (in Turkish)
- Gurbuz, A., Divanli, T.A., Soydas, S., Aydin, N., 2004. Correlation and path analysis in chickpeas. Journal of Field Crops Central Research Institute, 10: 1302-4310. (in Turkish)
- Kadioglu, S. Kara, A., Kucuk, N., 2006. Project on Determination of Economic Competitive Power within the Forage Crops Production System in Erzurum. Final Report, Project No: TAGEM /TA/03/04/01/008 EAARI / Erzurum. (in Turkish)
- Kadioglu, S., 2015. Determination of winter tolerance and some agronomic characteristics of some forage pea genotypes in Erzurum ecology. 11. Field Crops Congress, 7-10 September 2015, Canakkale, p: 163-167. (in Turkish)
- Kadioglu, S., Tan, M., 2018. Determination of seed yields and some properties of some forage pea lines and varieties under Erzurum conditions. Ataturk University Journal of Agricultural Faculty, 49 (2): 143-149. (in Turkish with abstract in English)
- Kadioglu, S., Kadioglu, B., Koc, A., 2019. Effect of phosphorous fertilizer and bacterial applications on seed yield of morphologically different forage pea (*Pisum sativum* L.) varieties. Eurasian Journal of Agricultural Research, 3: 14-23. (in Turkish with abstract in English)
- Kaya, M., 2000. Effects of different grafting methods, nitrogen fertilizer doses and sowing times on yield and yield components of Winner pea (*Pisum sativum* L.) cultivar. Ankara University Institute of Science, Ph.D. Thesis, Ankara, 193 p. (in Turkish)
- Keskin, B., Temel, S., 2018. Seed yields of some forage pea (*Pisum sativum* ssp. *arvense* L.) varieties in different sowing times in Iğdir ecological conditions I. International Iğdir Congress on Multidisciplinary Multidisciplinary Studies, 6-8 November 2018, Iğdir, p: 231-241.
- Kılınç, H.V., 2017. Determination of Morphological Characterization of Local Pea (*Pisum sativum* L.) Populations Growing in Giresun Province. Ordu Univ. Institute of Science, Master Thesis, Ordu, 68 p. (in Turkish)

- Koivisto, J. M., Lane, G.P.F., Davies, W.P., Durand, J.L., Emile, J.C., Huyghe, C., Lemarie, G., 2002. Growth and development of semi-leafless grain and forage peas, Multi function grasslands: Quality forages, animal products and landscapes. Proceedings of the 19 th General Meeting of the EGF, 27-30 May 2002, France, pp: 430-431.
- Onder, M., Ceyhan, E., 2001. Determination of grain, stalk and pod yield and harvest index of peas (*Pisum sativum* L.) cultivated at different times. Journal of Selcuk University Faculty of Agriculture, 15 (25): 173-183. (in Turkish with abstract in English)
- Oz, M., Karasu, A., 2010. Determination of seed yield and yield components of some pea (*Pisum sativum* L) cultivars. Journal of Suleyman Demirel University, Journal of Faculty of Agriculture, 5 (1): 44-49. (in Turkish)
- Ozbek, H., 1980. Bees pollinating the feed pea (*Pisum arvense* L.) in Kars region. Turkey Journal of Plant Protection, 4 (3): 193-195. (in Turkish)
- Ozkaynak, I., 1980. Selection Breeding Studies on Forage Pea (*Pisum arvense* L.) Local Varieties. Ankara University, Faculty of Agriculture, Ulucan Printing House, Ankara, 85 p. (in Turkish)
- Qasim, M., Zubair, M., Wandan, D., 2001. Evaluation of exotic cultivars of pea in Swat Valley. Sarhad Journal of Agriculture, 17(4): 545-548.
- Sayar, M.S., Anlarsal A.E., 2008. A research on determination of yield and yield components of some forage pea (*Pisum arvense* L.) lines and varieties in Diyarbakir ecological conditions. Journal of Cukurova University Institute of Science and Engineering, 17 (4): 78-88. (in Turkish)
- Sayar, M., Anlarsal, A., Acikgoz, E., Basbag, M., Gul, I., 2009. Determination of yield and yield components of some forage pea (*Pisum arvense* L.) lines in Diyarbakir conditions. Turkey VIII. Field Crops Congress, Volume: I, 19-22 October 2008, Hatay, p: 646-650.
- Sayar, M.S., Han, Y., 2016. Forage yield performance of forage pea (*Pisum sativum* spp. *arvense* L.) genotypes and assessments using GGE biplot analysis. Journal of Agricultural Science and Technology, 18 (6): 1621-1634.
- Seyis, F., 1994. A Study on Grain Yield and Some Important Properties of Pea Cultivars Planted in Samsun Ecological Conditions and Their Relationships. Ondokuz Mayıs University Institute of Science, Master Thesis, Samsun, 63 p. (in Turkish)
- Tamkoc, A., 2007. Yield and some vegetative properties of forage pea lines planted for the winter. Turkey VII. Field Crops Congress, Meadow Pasture, Forage Crops and Industrial Crops, 25-27 June 2007, Erzurum, p: 95-97. (in Turkish)
- Tan, M., Koc, A., Dumlu Gul, Z., 2012. Morphological characteristics and seed yield of East Anatolian local forage pea (*Pisum sativum* ssp. *arvense* L.) ecotypes. Turkish Journal of Field Crops, 17 (1): 24-30.
- Tan, M., Koc, A., Dumlu Gul, Z., Elkoca, E., Gul, I., 2013. Determination of dry matter yield and yield component of local forage pea (*Pisum sativum* ssp. *arvense* L.) ecotypes. Journal of Agricultural Sciences, 19: 289-296.
- Tan, M., 2018. Legume and Grass Forage Crops. Atatürk University Faculty of Agriculture Course Publications. No: 190, Erzurum, 286 p. (in Turkish)
- Tekeli, A.S., Ates, E., 2003. Yield and its components in field pea (*Pisum arvense* L.). J. Cent. Eur. Agric., 4: 313-318.
- Timuragaoglu, K.A., Genc, A., Altinok, S., 2004. Forage and seed yields in forage pea lines under Ankara conditions. Ankara University Faculty of Agriculture, Journal of Agricultural Sciences, 10 (4): 457-461. (in Turkish with abstract in English)
- Togay, N., Togay, Y., Erman, M., Yildirim, B., 2006. The effect of different plant frequencies on some agricultural characteristics in two winter pea lines (*Pisum sativum* ssp. *arvense* L.). YYU Journal of Agricultural Sciences, 16 (2): 97-103. (in Turkish with abstract in English)
- Uzun, A., Bilgili, U., Sincik, M., Filya, I., Acikgoz, E., 2005. Yield and quality of forage type pea lines of contrasting leaf types. European Journal and Agronomy, 22: 85-94.
- Uzun, A., Gun, H., Acikgoz, E., 2012. Determination of grass, seed and crude protein yields of some forage pea (*Pisum sativum* L.) varieties that are harvested at different developmental stages. Journal of Uludag University Faculty of Agriculture, 26 (1): 27-38. (in Turkish with abstract in English)
- TUMAS, 2019. Turkey Meteorological Data Archive System. www.tumas.mgm.gov.tr (Accessed Date: 10 August 2019). (in Turkish)
- Yilmaz, S., 2010. Effect of Different Phosphorus Doses on Seed Yield and Some Seed Yield Criteria of Forage Pea (*Pisum arvense* L.). Namik Kemal University Institute of Science, Master Thesis, Tekirdag, 37 p. (in Turkish).