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Full Length Research Paper

Seed yields and biochemical compounds of common vetch (*vicia sativa* L.) lines grown in semi-arid regions of Turkey

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Common vetch (*Vicia sativa* L.) is used for grain, hay or green manure in the semi-arid regions of Turkey. The objective of this study was to determine the seed yields and biochemical compounds of seeds for common vetch lines grown under rain-fed conditions in semi-arid regions of Turkey. Four common vetch lines (845, 2640, 1448 and 384) were obtained from the international center for agricultural research in dry areas (ICARDA). Field experiments were designed according to randomized block design with three replications during 2004/05 and 2005/06. Seed yields, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), crude fat (CF) and amino acid (aa) contents of common vetch lines were determined. Seed yields ranged from 1160 - 1459 kg.ha^{-1}, CP content ranged from 24.94 - 27.86%, ADF content ranged from 5.81 - 8.45%, NDF ranged from 9.89 - 11.42% and CF content ranged from 1.16 - 3.23% based on the averages of the two years results.

Key words: Common vetch, crude protein content, acid detergent fiber content, amino acid.

INTRODUCTION

Traditional cereal/fallow cropping system is preferred by farmers in the arid and semi-arid regions of Turkey. Grain legumes have been lately taken into considerable attention in the central and southeastern areas of Turkey and Meditterranean-type environments. Vetches (*Vicia* spp.), grasspea (*Lathyrus* spp.), lentil (*Lens culinaris* Medik.) and chickpea (*Cicer arietinum* L.) have good drought resistance features and can adapt to unfavorable environments easily (Acikgoz, 1988; Abd El-Moneim et al., 1990). Vetches (*Vicia* spp.) are particularly the most important forage crop in Turkey grown for green herbage, hay and seed production. The crop may be used as dual-purpose for both grain and hay or green manure (Abd El-Moneim, 1993; Miyan et al., 1997; Turk et al., 2003).

The seeds of vetches are also widely used as a concentrate feed mixed with straw or cereal grains for livestock (Abd El-Moneim et al., 1990). Although, common vetch has quite high crude protein content (Abd El-Moneim, 1993), it contains an unsuitable poisonous compound (γ-glutamyl-β-cyanoalanine) for monogastric animals and humans. γ-Glutamyl-β-cyanoalanine has a bad influence on sulphuric amino acid metabolism and is responsible for a disease called favism (Mihailovic et al., 2005). Saki et al. (2008) reported that ten percent of common vetch in the diet did not cause problem in the growing broiler performance. Ruminants have shown toxicity at higher levels of common vetch. Toxicity could be removed with steaming and leaching (Enneking, 1995).

Seed yield and chemical compounds of common vetch lines can be affected by adverse agricultural conditions (Milczak et al., 2001). Increased neutral detergent fiber (NDF) and acid detergent fiber (ADF) affect lowering

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Abbreviations: CP, Crude protein; **ADF,** acid detergent fiber; **NDF,** neutral detergent fiber; **CF,** crude fat; **aa,** amino acid; **P,** phosphorus; **K,** potassium; **ICARDA,** international center for agricultural research in dry areas.

Table 1. Two-years averaged values of seed yields and crude protein contents of common vetch lines grown in Kazova-Tokat and Suluova- Amasya during 2004/05 and 2005/06.

Lines	Seed yield (kg.ha^{-1})			Crude protein content (%)		
	Tokat	Amasya	Mean	Tokat	Amasya	Mean
845	1385	934	1160 b	20.99 e	28.90 bc	24.94 b
2640	1771	1146	1459 a	24.83 d	27.87 c	26.35 ab
1448	1632	1217	1425 a	22.68 de	30.77 ab	26.72 a
384	1630	995	1313 ab	24.34 d	31.38 a	27.86 a
Mean	1605 a	1073 b	1339	23.21 b	29.73 a	26.47
LSD_{Lo}	22.29**			1.74*		
LSD_{Ln}	22.29**			2.12*		
LSD_{LoxLn}	ns			2.46*		

Lo: Location; Ln: line; LoxLn: line x location interaction; *significant at p<0.05; **significant at P<0.01; ns: not significant. Means of different line-location combinations with the same letter are not statistically significant according to the LSD test at P<0.05. Means of locations with the same letter are not statistically significant at p<0.05.

intake and digestions of the animals (Van Soest et al., 1991; Van Soest, 1994). Higher crude protein (CP) content is important for feeding ruminants, while essential amino acid content is more important than CP values for the monogastric animals (Roy, 1981). Firincioglu et al. (2007) reported that some variations between the common vetch lines are in terms of toxicity levels. Therefore, the objective of this study was to investigate the seed yields and biochemical compounds of seeds of common vetch lines (*V. sativa* L.) grown under rain-fed conditions in semi-arid regions of Turkey.

MATERIALS AND METHODS

The studies were conducted at two locations, the research station of Field Crops Department, Agricultural Science Faculty, Gaziosmanpasa University, (40°13´ - 40°22´ N, 36°1´ - 36°40´ E, altitude 623 m) in Kazova-Tokat and Suluova-Amasya (40°50' - 40°84' N, 35°38' - 35°64' E, altitude 541 m), during the growing season of 2004/05 - 2005/06. Soil samples from both locations were collected at a depth of 0 – 20 cm. The soils were slightly alkaline, medium in calcium carbonate and phosphorus (P) content, high in potassium (K) and poor in organic matter content. Average temperatures of 11.3, 10.8 and 11.5°C were recorded between October and June during 2004/05, 2005/06, and long-term averages in Tokat-Kazova, respectively. Average temperatures were recorded as 12.4, 11.4 and 11.9°C between October and June during 2004/05, 2005/06 and long-term periods in Suluova-Amasya, respectively. Total precipitations of 508.9, 375.9 and 405.3 mm were recorded between October and June during the 2004/05, 2005/06 and long-term periods in Kazova-Tokat, respectively. Total rainfalls of 506.1, 439.5 and 421.3 mm were recorded between October and June during 2004/05, 2005/06 and long-term periods in Suluova-Amasya, respectively. Site characteristics and agronomic details are very important for evaluation of yield and biochemical traits of vetch.

Four common vetch lines (845, 2640, 1448, 384) were obtained from the International Center for Agricultural Research in Dry Areas (ICARDA). Seeds were sown on the first of November and 27th of October, 2004 and 2005 in Kazova-Tokat and on 4th of November and 25th of October, 2004 and 2005 in Suluova-Amasya conditions, respectively. Plot size was 5 x 1.8 m. Sowing rate was 120 kg. ha^{-1}, 30 kg. N ha^{-1} and 80 kg. P_2O_5 ha^{-1}, were uniformly applied to soil before sowing. Seeds were harvested at maturity, acid detergent fiber and neutral detergent fibers in seeds were analyzed according to Van Soest et al. (1991). The crude fat (CF) content was determined using Soxhlet methods (AOAC, 1984). Nitrogen content in seeds was determined by the Kjeldahl procedure described by Nelson and Sommers (1980), and crude protein content was calculated by multiplying the nitrogen content values by 6.25. During 2004 - 05, seeds were also analyzed for amino acid content using Phenomenex EZ Faast GC-FID hydrolyzed amino acid analysis kit (Anonymous, 1998). Analysis of variance and least significant difference (LSD) test for mean comparisons were performed as outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Seed yield

Seed yields varied between locations and lines (Table 1). Two-years results indicated that line 2640 produced the highest seed yield (1459 kg.ha^{-1}), whereas, line 845 had the lowest seed yield (1160 kg.ha^{-1}). According to locations, average seed yields were obtained as 1605 and 1073kg.ha^{-1} in Kazova-Tokat and Suluoava-Amasya, respectively. While similar seed yield values were reported by Abd El-Moneim (1985; 1993), Karadag and Buyukburc (2001); the seed yield values obtained in the current experiment were greater than those reported by Nan et al. (2006).

Seed yields were affected by lines and locations. Location x year interaction for seed yield was also statistically significant. Ecological conditions and genotypes tested might cause such a difference. Abd El-Moneim (1993) stated that seed yields of *Vicia* species were linearly related to total rainfall in similar ecological conditions. Critical period of forage legumes in terms of water is from

Table 2. Amino acid contents of common vetch lines grown in Kazova-Tokat and Suluova Amasya in the growing season of 2004-05.

Locations	Tokat				Amasya			
Lines	845	2640	1448	384	845	2640	1448	384
CP %	20.99	24.83	22.68	24.34	28.90	27.87	30.77	31.38
(%) Amino acids in CP								
Alanine (Ala)	0.98	1.04	1.11	0.98	1.05	1.15	1.15	1.07
Glycine (Gly)	1.02	0.98	1.10	0.98	1.06	1.07	1.33	1.04
*Valine (Val)	1.18	1.17	1.21	1.11	1.22	1.28	1.29	1.20
*Leucine (Leu)	2.03	1.95	1.99	2.01	2.26	2.11	2.24	2.33
*Isoleucine (Ile)	1.15	1.17	1.14	0.99	1.10	1.23	1.09	1.19
*Threonine (Thr)	0.86	0.87	0.97	0.91	0.91	0.94	0.89	1.00
Serine (Ser)	1.10	1.06	1.48	1.39	1.23	1.38	1.28	1.51
Proline (Pro)	1.34	1,10	1.24	1.13	1.25	1.29	1.29	1.28
Aspartic acid (Asp)	3.67	4.74	3.66	3.65	4.61	3.65	3.52	3.74
*Methionine (Met)	0.00	0.00	0.00	0.02	0.00	0.00	0.19	0.00
Proline (Pro)	0.20	0.00	0.16	0.04	0.05	0.17	0.13	0.00
Glutamic acid (Glu)	2,79	3.47	4.02	4.05	4.23	4.69	4.01	4.46
*Phenylalanine (Phe)	1.20	1.09	1.10	1.07	1.08	1.14	1.21	1.20
*Lysine (Lys)	1.44	1.43	1.24	2.07	1.67	1.46	1.40	2.31
*Histidine (His)	0.00	0.00	0.00	0.69	0.90	1.10	0.87	0.83
Tyrosine (Tyr)	0.90	0.76	0.77	0.73	0.75	0.79	0.83	0.81

*Essential amino acids; CP: crude protein.

the beginning of flowering to seed formation (Barnes et al., 2003). Yield could be low even if the water requirement is met after this critical period (as in many crop species). In Suluova_Amasya location, the low seed production was probably related to drought periods in spring, particularly in May.

CP

Seed crude protein percentage was statistically significantly influenced by locations and lines, and location x line interaction was also statistically significant (Table 1). In Kazova-Tokat location, the crude protein levels varied between 24.83 - 20.99%, depending on the lines. In Suluova-Amasya location, these values changed from 31.38 - 27.87%, depending on the lines. The average crude protein content varied between 27.86 - 24.94%, depending on the lines. Buyukburc and Karadag (2001) reported similar CP values; however, our CP values were higher than the findings of Corleto (1976), Darre et al. (1998) and Caballero et al. (2001). Differences between locations and the years in precipitation and temperature as well as the different lines in the field experiments may have contributed to the differences in protein content

Amino acid (aa)

Amino acid contents of lines are presented in Table 2. Methionine amino acid was not found in the seeds of the common vetch lines, except lines 384 and 1448. These lines were also very low in methionine level. Aspartic acid and glutamic acid percentages were higher than those of the other amino acids. Aspartic acid content was the highest (4.74%) in line 2640 at Kazova-Tokat location. Hadjipanayiotou and Economides (2001) reported that the amino acids with the lowest percentage in the crude protein of common vetch seeds were methionine (0.44%), alanine (0.44%) and proline (0.44%), while that with the highest percentage was aspartic acid (2.54%). Caballero et al. (2001) also reported that the amino acids with the highest (13.63%) and the lowest percentage (1.36%) content were aspartic acid and methionine, respectively. On the other hand, Milczak et al. (2001) reported that the amino acid with the lowest concentration (0.80%) in the crude protein of grasspea seeds was tryptophan (0.80%), and that with the highest concentration (19.91%) was glutamic acid. They have also reported that methionine and aspartic acid contents of crude protein of grasspea seeds were 1.35-14.80%, respectively.

Table 3. Two-years averaged values of acid detergent fiber and neutral detergent fiber contents of common vetch lines grown in Kazova-Tokat and Suluova-Amasya during 2004/05 and 2005/06.

Lines	Acid detergent fiber content (%)			Neutral detergent fiber content (%)		
	Tokat	Amasya	Mean	Tokat	Amasya	Mean
845	6.24 bc	9.98 a	8.11 ab	8.33 b	11.45 a	9.89 b
2640	5.40 bc	7.14 b	6.27 bc	8.73 b	11.37 a	10.05 b
1448	6.84 bc	10.06 a	8.45 a	10.72 a	12.12 a	11.42 a
384	4.92 c	6.70 bc	5.81 c	11.14 a	11.09 a	11.11 ab
Mean	5.85 b	8.47 a	7.16	9.73 b	11.51 a	10.62
LSD_{Lo}	1.48**			1.28**		
LSD_{Ln}	2.10**			1.34*		
LSD_{LoxLn}	2.19*			1.89*		

Lo: Location; Ln: line; LoxLn: line x location interaction;*significant at P<0.05; **significant at P<0.01; ns: not significant. Means of different Line-location combinations with the same letter are not statistically significant according to the LSD test at p<0.05. Means of locations with the same letter are not statistically significant at p<0.05.

Table 4. Two-years averaged values of crude fat content of common vetch lines grown in Kazova-Tokat and Suluova-Amasya during 2004/05 and 2005/06.

Lines	Crude fat content (%)		
	Tokat	Amasya	Mean
845	3.13 a	3.10 a	3.12 a
2640	3.49 a	0.26 d	1.88 b
1448	3.19 a	3.28 a	3.23 a
384	0.76 c	1.57 b	1.16 c
Mean	2.64 a	2.05 b	2.35
LSD_{Lo}		0.24^{**}	
LSD_{Ln}		0.34^{**}	
LSD_{Loxn}		0.48^{**}	

Lo: Location; Ln: line; LoxLn: line x location interaction;*significant at P<0.05; **significant at P<0.01; ns: not significant. Means of different Line-location combinations with the same letter are not statistically significant according to the LSD test at p<0.05. Means of locations with the same letter are not statistically significant at p<0.05.

ADF

ADF content of the seeds of common vetch was statistically and significantly influenced by locations and lines, and locations x lines interaction was also statistically significant (Table 3). Ecological conditions and the lines used in the field experiments could cause these differences. Two years result indicated that the line 1448 produced the highest acid detergent fiber content (8.45%), whereas, the line 384 had the lowest acid detergent fiber content (5.81%) depending on the locations, and average acid detergent fiber content varied between 5.85-8.47% in Kazova-Tokat and Suluova-Amasya, respectively. This variation could be caused by climatic differences, especially higher air temperatures during the months of June - July in Amasya location as compared to those in Kazova-Tokat. Hadjipanayiotou and Economides (2001), Caballero et al., (2001) and Gonzales and Andres (2003) reported higher ADF values than our values. Since, ADF values have negative correlation with ruminant digestion (Van Soest, 1994), lower values of ADF are preferable for the animal production.

NDF

Neutral detergent fiber content was also statistically and significant influenced by locations and lines, and location x line interaction was also statistically significant (Table 3). Ecological conditions, such as precipitation and temperature, as well as the lines used in the field experiment could cause these differences. In Kazova-Tokat location, the highest (11.14%) and the lowest (8.33%) neutral detergent fiber contents were obtained from the lines 384 and 845, respectively. In Suluova-Amasya location, the highest (12.12%) and the lowest (11.09%) neutral detergent fiber contents were obtained from the lines 1448 and 384, respectively. NDF content of seeds of common vetch grown in Suluova-Amasya location was higher than that grown in Kazova-Tokat. This could result from the higher air temperature, which was recorded during the month of June - July in Amasya location. Hadjipanayiotou and Economides (2001), Caballero et al. (2001) and Gonzales and Andres (2003) reported higher NDF values than our results. Since, NDF values negatively associated with animal intake, NDF values of seeds should be lower for monogastric and ruminant animals (Van

CF

Effects of locations and lines on crude fat content were statistically significant. Location x line interaction was also statistically significant (Table 4). The highest crude fat content (3.49%) was obtained from the line 2640 while the lowest (0.76%) was obtained from the line 384 in Kazova-Tokat location. In Suluova-Amasya location, the highest and the lowest crude fat contents (3.28 - 0.26%) were obtained from the lines 1448 and 2640, respectively. According to the averages of the two years values, the lowest crude fat content (1.16%) was obtained from the line 384, and the highest crude fat content (3.23%) was obtained from the line 1448. The CF contents obtained in this study were higher than the findings of Caballero et al. (2001) and Milczak et al. (2001). Ecological conditions and the different lines may have caused these differences. In the feed, fat content are usually added to meet animal energy requirements (Church and Pond, 1988).

The yield and chemical compositions of common vetch seeds were affected by lines and ecological conditions. Farmers could use 1448, 2640 and 384 as common vetch lines, which had similar seed yield and chemical components under different locations and climatical conditions.

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