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Effect of different sowing times on growth attributes, forage yield and quality in three narbon vetch (*Vicia narbonensis* L.) genotypes at subtropical climate

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Abstract
A study was conducted in 2016-2018 growing seasons at Research and Experimental Area, Field Crops Department, Faculty of Agriculture, Namik Kemal University, Tekirdag, Turkey to record the effects of different sowing times (November, December, January and February) on some growth attributes, forage yield and quality on three narbon vetch (*Vicia narbonensis* L.) genotypes (Dikili, Bozdag and Ozgen). The highest plant height (75.84 cm) was recorded from 1^{st} sowing time, but highest leaf/stem ratio (1.78) was found at 4^{th} sowing time. The number of branches varied between 1.64 and 2.89. The highest main stem diameter was obtained from genotype Bozdag at 1^{st} sowing time (7.96 mm). The highest herbage (28.23-27.37 t ha^{-1}) and hay (5.91-5.81 t ha^{-1}) yields were obtained from genotypes Ozgen and Dikili at first sowing time. The lowest crude fiber contents were recorded from genotypes Dikili and Bozdag at 1^{st} sowing time (18.18-18.34%). The acid detergent fiber, neutral detergent fiber and acid detergent lignin contents were increased in all genotypes at late sowing. The phosphorus, potassium and magnesium contents were increased in all narbon vetch genotypes at late sowing. Calcium content was varied between 0.83 and 1.25%. The highest Cu (20.10 ppm), Mn (74.39 ppm) and Fe (206.67 ppm) contents were found at 3^{rd} sowing time.

Keywords: Forage yield, Growth attributes, Narbon vetch genotypes, Quality attributes, Sowing time

Introduction

World population is currently growing at a rate of around 1.05% per year. Recently, population has reached 7.8 billion. The current average population increase is estimated at 81 million people per year (Anonymous, 2020). Hence, changes in anthropogenic and global climatic conditions are expected leading to insufficient agricultural production, imbalanced distribution of production and global hunger. For an adequate and balanced diet, 70-80 g protein is required for an adult both from plant (45%) as well as animal (55%) foods (Ates and Tekeli, 2001; Anonymous, 2008). Accordingly in future, numbers of ruminant, non-ruminant animals and its productions need to be increased to meet the demands of world population. Thus, forage requirements of ruminant and non-ruminant animals need also to be obtained and met from available cultivated areas and grasslands in the world (Shinde and Mahanta, 2020). For this purpose, suitable forage grasses and legumes to be grown in a particular region are indispensable.

Legume family (*Fabaceae*), with its 727 genera and 19325 species (Lewis *et al*., 2005), is the largest family after orchid (*Orchidaceae*) and aster (*Asteraceae*) families in the plant kingdom. Legume family, which includes species with great differences in morphological and agricultural characters, has spread all over the world with its annual, biannual and perennial species (Tekeli and Ates, 2011). Annual legumes are utilized in the form of herbage, hay, forage meal, grain, straw and silage, while some of them are suitable for grazing as well (Mihailović *et al*., 2007). Indeed, forage legumes have an important place in animal feeding and nutrition (Ates, 2015). The vetch species (*Vicia* sp.) in this family constitute the most common group among cultivated annual forage legumes. There are about 150-190 vetch species, most of which are grown in temperate regions of the old world covering Asia, Europe and Africa (ILDIS, 1999). The flora of Turkey also possesses 59 vetch species (Davis and Plintman, 1970). Among these, narbon vetch (*Vicia narbonensis* L.) is important as a grain and straw forage crop for animals in subtropical regions (Bennett and Maxted, 1997). It is tolerant to cold and drought (Açýkgöz, 2001; Firincioglu *et al*., 2012). But global climate changes are expected to affect the yield and quality this forage crops also and we need to change in cultivation practices (sowing, fertilization, irrigation, harvest times etc.) to reduce its impact. The aim of the present study was to record the effect of different sowing times on forage yield and its components, nutritive values of three narbon vetch genotypes at subtropical conditions of Turkey.

Materials and Methods

Study site and experimental design: This study was conducted during 2016-2018 at Research and Experimental Area (40°59' 25.2" N, 27°34' 48.4" E), Field Crops Department, Faculty of Agriculture, Namik Kemal University, Tekirdag, Turkey in randomized split block design with three replications. The total rainfall received during 2016-17 was 502.7 mm and it was 472.2 mm (6.01% less) during 2017-18. Maximum rainfall was received in the month of November (107.4 mm) followed by January (107.0 mm). Mean temperature was 11.8 ºC during 2016-17, while it was 13.9 ºC during 2017-18. The soil of the experimental site was slighly alkine with pH of 7.56, salt content of 0.02%, organic matter content of 1.67%, total nitrogen content of 0.125%, phosphorus content of 8.62 ppm and potassium (K) content of 293 ppm.

Certified seed of the narbon vetch genotypes Bozdag, Ozgen and Dikili were used. Each plot consisted of 6 rows 25 cm apart and 5 m in length. The seeds were sown at a rate of 150 kg ha^{-1} (Tekeli and Ates, 2011) on November 20, 2016 (1^{st} sowing time), December 20, 2016 (2^{nd} sowing time), January 20, 2017 (3^{rd} sowing time) and February 20, 2017 (4^{th} sowing time) during 2016-17 and on November 09, 2017 (1^{st} sowing time), December 12, 2017 (2^{nd} sowing time), January 01, 2018 (3^{rd} sowing time) and February 20, 2018 (4^{th} sowing time) during 2017-18 with a hand-seeder. At each year, a basal fertilizer containing N and P (40 kg ha^{-1}) was incorporated into the soil at the time of land preparation. Weed control was done by hand pulling. Plant height (cm), stem diameter (mm), number of branches per plant and leaf/stem ratio was measured in 10 plants at full-bloom stage, which were randomly chosen from all plots. Main stem diameter was measured between the third and fourth node. Plant samples hand separated to leaf and stem and weighed to determine leaf/stem ratio. To determine the herbage yield (t ha^{-1}) harvests were made at full-bloom and first pods from bottom were turn into grain filling from an area of 2.5 m^2 (Tekeli and Ates, 2011). Approximately 500 g herbage samples were subjected to two turnings; the first one at 24 hours and the second 48 hours after it was spread on the field for drying. Then samples were stored for one day at room temperature and hay yield (t ha^{-1}) was calculated.

Chemical analyses: Hay samples were ground to small (1 mm) pieces and used for the laboratory analyses. The crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) contents (%) were determined following the Van Soest *et al*. (1991) and AOAC (2007). The samples were wet-fired with nitric-perchloric acid, and phosphorus (P) content (%) was determined spectrophotometrically, while potassium (K, %), calcium (Ca, %), magnesium (Mg, %), copper (Cu, ppm), zinc (Zn, ppm), manganese (Mn, ppm) and iron (Fe, ppm) contents were obtained using an atomic absorption spectrophotometer (ICP-OES, inductively coupled plazma-optical emission spectrometer) (Plank, 1992; Isaac and Johnson, 1998). Tetany ratios (K/Ca + Mg) were then calculated (Cherney *et al*., 2002).

Statistical analyses: The data were analyzed using the TARIST statistical computer package. Mstat-C programmer was used for the comparison (Fisher's least significant difference, LSD) of the means from the two years.

Results and Discussion

Growth attributes: The data on growth attributes (Table 1) revealed that the plant height and leaf/stem ratio were affected by sowing time ($P<0.01$). The highest plant height (75.84 cm) was measured from 1^{st} sowing time, but highest leaf/stem ratio (1.78) was recorded at 4^{th} sowing time. There were no significant ($P>0.05$) differences in genotype, sowing time and genotype x sowing time interactions on number of branches per plant. The numbers of branches were varied from1.64 to 2.89. In addition to a significant genotypic effect, sowing time and genotype x sowing time effects were significant for main stem diameter ($P<0.01$). Main stem diameter was varied from 7.96 to 5.70 mm and the highest main stem diameter was obtained from genotype Bozdag at 1^{st} sowing time (7.96 mm). Morphological characters of forage crops generally varied depending on genotype, climate and soil conditions and other ecological factors and these were affected forage yield and quality features (Ates, 2011a). Besides, the most important factors affecting forage quality is the leafiness of forage crops. Ruminant and non-ruminant animals prefer stems of forage crops that are hollow, watery and low in lignin content. For this type of forage legume and grasses, the stem diameter is desirable. Nevertheless, thickness of stem decreases of the digestibility and protein content of the forage, and leads to a resultant decrease in forage quality (Ball *et al*., 2001; Tan *et al*., 2013). Orak and Nizam (2009) and Ileri *et al*. (2016) reported that the plant height decreased as the sowing time delays. Nizam *et al*. (2011) reported that the plant height ranged from 43.02 to 78.85 cm in narbon vetch. Ates (2014) emphasized that the fleshy thick branches and leaves of narbon vetch are not suitable for hay due to difficulty in field drying. The plant height, number of branches per plant and main stem diameter also ranged from 63.8 to79.3 cm, 1.93 to 3.40 and 3.32 to 4.97 mm, respectively in narbon vetch (Sayar and Han, 2014). Thus the present findings were similar to those reported earlier.

Herbage and hay yield: The effects of genotype, sowing time and genotype x sowing time interactions on herbage and hay yields were found significant (P<0.01; Table 1). The highest herbage (28.23-27.37 t ha^{-1}) and hay (5.91-5.81 t ha^{-1}) yields were obtained from genotypes Ozgen and Dikili at first sowing time. Herbage yield also varied from 13.36 to 54.48-46 t ha^{-1} in vetch species as observed earlier (Basbag and Gül, 2004; Nizam *et al*., 2009; Rahmati *et al*., 2012; Seydosoglu *al*., 2014; Çaçan and Kökten, 2017). Similarly hay yields of some vetch species were ranged from 1.36 to 9.35 t ha^{-1} (Nizam *et al*., 2011; Sayar and Han, 2014; Seydosoglu *et al*., 2014), whereas Kaplan *et al*. (2017) observed this yield varied only from 0.20 to 0.35 t ha^{-1}.

CP and cell wall components: The CP and CF contents were influenced significantly by genotype, sowing time and genotype x sowing time interactions (P<0.01). The highest CP (17.34 %) content was recorded at 3rd sowing time in narbon vetch genotypes. The highest crude protein content was obtained from genotype Dikili (15.34%). The lowest CF contents were recorded from genotypes Dikili and Bozdag at 1st sowing time (18.18 to 18.34%) (Table 2). The ADF, NDF and ADL contents were increased in all genotypes at late sowing. The highest ADF (31.49%), NDF (44.30%) and ADL (9.70%) contents were found at 4th sowing time (Table 2). Generally, forage legumes typically contain higher levels (12-26%) of protein compared to grasses (8-22%). In forages, however, leaves and stems quality begin to decline early in the growth cycle due to deposition and lignifications of cell

Table 1. Morphological characteristics and forage yield of narbon vetch genotypes under different sowing times

Genotype	***Plant height (cm)***					***Main stem diameter (mm)***				
	Sowing time					**Sowing time**				
	1	**2**	**3**	**4**	**Average**	**1**	**2**	**3**	**4**	**Average**
Dikili	77.95	60.22	46.82	41.26	56.56	7.08 b	7.30 ab	6.07 cd	6.13 cd	6.65 a
Bozdag	72.00	56.83	48.51	40.47	54.46	7.96 a	5.82 d	5.70 d	6.00 cd	6.37 ab
Özgen	77.56	59.19	51.38	40.42	57.14	6.63 bc	5.88 d	5.77 d	5.83 d	6.03 b
Average	75.84 a	58.75 b	48.90 c	40.72 d	56.05	7.22 a	6.33 b	5.99 bc	5.85 c	6.35
LSD	Sowing time: 6.296** Genotype: NS Sowing time x Genotype: NS					Sowing time: 0.363** Genotype: 0.344** Sowing time x Genotype: 0.687**				
Genotype	***Branches/plant***					***Leaf/stem ratio***				
	Sowing time					**Sowing time**				
	1	**2**	**3**	**4**	**Average**	**1**	**2**	**3**	**4**	**Average**
Dikili	2.89	2.78	1.83	2.42	2.48	1.39	1.41	1.46	1.78	1.51
Bozdag	2.34	1.64	1.86	2.31	2.04	1.24	1.33	1.43	1.73	1.44
Özgen	2.03	2.89	2.25	2.39	2.39	1.14	1.23	1.38	1.83	1.40
Average	2.42	2.44	1.98	2.37	2.30	1.26 b	1.33 b	1.42 b	1.78 a	1.45
LSD	Sowing time: NS Genotype: NS Sowing time x Genotype: NS					Sowing time: 0.241** Genotype: NS Sowing time x Genotype: NS				
Genotype	***Herbage yield (t ha^{-1})***					***Hay yield (t ha^{-1})***				
	Sowing time					**Sowing time**				
	1	**2**	**3**	**4**	**Average**	**1**	**2**	**3**	**4**	**Average**
Dikili	27.37 ab	19.33 de	16.33 efg	13.33 gh	19.09 ab	5.81 ab	3.78 cd	3.63 d	2.74 ef	3.99 a
Bozdag	24.80 bc	16.00 fg	15.67 fg	14.00 gh	17.62 b	5.21 b	3.27 de	3.28 de	2.89 ef	3.66 b
Özgen	28.23 a	21.67 cd	17.83 ef	11.67 h	19.85 a	5.91 a	4.38 c	3.67 d	2.54 f	4.12 a
Average	26.80 a	19.00 b	16.61 c	13.00 d	*18.85*	5.64 a	3.81 b	3.53 b	2.72 c	*3.93*
LSD	Sowing time: 1.742** Genotype: 1.629** Sowing time x Genotype: 3.257**					Sowing time: 0.396** Genotype: 0.322** Sowing time x Genotype: 0.644**				

Values with different letters within columns and rows differed significantly (**P<0.01); NS: Non-significant (P>0.05)

Table 2. Nutrient content (%) of narbon vetch genotypes under different sowing times

Genotype	*Crude protein*					*Crude fiber*				
	Sowing time					Sowing time				
	1	2	3	4	Average	1	2	3	4	Average
Dikili	11.47 g	13.28 e	19.81 a	16.78 b	15.34 a	18.18 g	21.35 d	22.65 b	23.30 a	21.37 ab
Bozdag	12.44 f	12.78 f	15.54 c	15.44 c	14.05 c	18.34 g	20.83 e	22.40 b	23.35 a	21.26 b
Özgen	13.56 e	12.63 f	16.66 b	14.63 d	14.37 b	18.67 f	21.30 d	22.13 c	23.50 a	21.40 a
Average	12.49 d	12.90 c	17.34 a	15.62 b	*14.58*	18.44 d	21.16 c	22.39 b	23.38 a	*21.33*
LSD	Sowing time: 0.351** Genotype: 0.193** Sowing time x Genotype: 0.384**					Sowing time: 0.078** Genotype: 0.124** Sowing time x Genotype: 0.250**				
Genotype	***ADF***					***NDF***				
	Sowing time					**Sowing time**				
	1	**2**	**3**	**4**	**Average**	**1**	**2**	**3**	**4**	**Average**
Dikili	28.83	29.58	30.25	31.48	30.03 ab	40.20 f	41.88 d	42.55 c	44.30 a	42.24 a
Bozdag	28.85	29.53	30.33	31.58	30.07 a	39.98 g	41.75 e	42.55 c	44.28 a	42.14 b
Özgen	28.83	29.58	30.08	31.43	29.98 c	40.13 f	41.75 e	42.70 b	44.28 a	42.21 ab
Average	28.83 d	29.56 c	30.22 b	31.49 a	*30.03*	40.10 d	41.79 c	42.60 b	44.30 a	*42.19*
LSD	Sowing time: 0.103** ¥Genotype: 0.073* Sowing time x Genotype: NS					Sowing time: 0.117** Genotype: 0.082** ¥Sowing time x Genotype: 0.122*				
Genotype	***ADL***					***P***				
	Sowing time					**Sowing time**				
	1	**2**	**3**	**4**	**Average**	**1**	**2**	**3**	**4**	**Average**
Dikili	8.20 f	8.88 d	9.30 b	9.78 a	9.04 a	0.30 e	0.33 cde	0.41 a	0.37 b	0.35 a
Bozdag	8.05 g	8.65 e	9.18 c	9.75 a	8.91 b	0.30 e	0.32 de	0.31 de	0.34 bcd	0.31 c
Özgen	8.15 fg	8.73 e	9.10 c	9.80 a	8.94 b	0.31 de	0.31 de	0.36 bc	0.37 b	0.34 b
Average	8.13 d	8.75 c	9.19 b	9.78 a	*8.96*	0.30 b	0.32 b	0.36 a	0.36 a	*0.33*
LSD	Sowing time: 0.121** Genotype: 0.072** ¥Sowing time x Genotype: 0.109*					Sowing time: 0.017** Genotype: 0.017** Sowing time x Genotype: 0.003**				

Genotype means of ADF, sowing time x genotype interactions of NDF and ADL with different letter for the same column differed significantly different (*P<0.05); Other values with different letters within columns and rows differed significantly (**P<0.01); NS: Non-significant (P>0.05)

wall, especially in stems (Moore *et al*., 2007; Ates, 2011b). Redfearn *et al*. (2008) and Tenikecier and Ates (2019) emphasized the high producing dairy cows need hay with at least 20% CP, less than 30% ADF, and less than 40% NDF. However, forages with better CP, ADF, and NDF values are not necessarily better for milk production. The present values on CP, CF, ADF, NDF and ADL were similar to earlier studies (Nizam *et al*., 2009; Rahmati *et al*., 2012; Georgieva *et al*., 2016; Çaçan and Kökten, 2017; Kaplan *et al*., 2017; Semmana *et al*., 2019). They obtained the values of 10.44 to 25.06% for CP, 21.15 to 24.20% for CF, 5.17 to 9.33% for ADL and 31.90 to 69.35% for NDF contents in hays of different vetch species.

Macromineral content: There were no significant differences in genotype, sowing time and genotype x sowing time interactions on Ca content (Table 3). Ca content was varied between 0.83 and 1.25%. The contents of K, P and Mg were influenced significantly by genotype, sowing time and genotype x sowing time inter-actions (P>0.01). The P, K and Mg contents were increased in all narbon vetch genotypes at late sowing. The highest K content (2.73%) was found in genotype Ozgen at 3rd sowing time, whereas the highest P content (0.41%) was obtained from genotype Dikili at same sowing time. The highest Mg content (0.40%) was recorded at 3rd sowing time. Mineral balance is very important to keep animal healthy. Deficiency of one mineral element in the diet cannot be balanced by the others. These elements should be in certain ratio. For example, Ca and P are closely related to animal health and metabolism. It is very important to keep a proper balance of Ca and P in relation to vitamin D (Tekeli and Ates, 2005). Skeleton is containing approximately 68-73% of the Mg in the total Mg content of animal body. The content of P in the rumen is also important, with higher levels of P favoring magnesium absorption. Cows grazing P-deficient pastures might have low concentrations of P in the rumen, and Mg absorption might be further impaired. The Ca content in the blood also plays a role in

Table 3. Mean K, Ca, Mg contents (%) and tetany ratio of narbon vetch genotypes under different sowing times

Genotype	K					Ca				
	Sowing time					Sowing time				
	1	2	3	4	Average	1	2	3	4	Average
Dikili	1.72 l	2.35 f	2.55 c	2.61 b	2.31 b	0.83	1.13	1.20	1.09	1.08
Bozdag	1.74 l	2.58 bc	2.21 g	2.49 d	2.26 c	0.97	1.25	1.11	1.20	1.13
Özgen	2.17 h	2.16 h	2.73 a	2.40 e	2.36 a	1.23	0.99	1.25	1.10	1.06
Average	1.88 c	2.36 b	2.49 a	2.50 a	*2.31*	0.91	1.12	1.19	1.13	*1.11*
LSD	Sowing time: 0.016** Genotype: 0.019** Sowing time x Genotype: 0.040**					Sowing time: NS Genotype: NS Sowing time x Genotype: NS				

Genotype	Mg					Tetany ratio (K/Ca+Mg)				
	Sowing time					Sowing time				
	1	2	3	4	Average	1	2	3	4	Average
Dikili	0.20 g	0.29 de	0.44 a	0.28 de	0.30 b	2.26 e	2.41 d	2.57 b	2.67a	2.48 a
Bozdag	0.23 fg	0.32 d	0.38 bc	0.42 ab	0.34 a	2.03 f	2.38 d	2.37 d	2.50 bc	2.32 c
Özgen	0.29 de	0.25 ef	0.38 bc	0.37 c	0.32 a	2.06 f	2.44 cd	2.56 b	2.55 b	2.40 b
Average	0.24 d	0.29 c	0.40 a	0.36 b	*0.32*	2.12 d	2.41 c	2.50 b	2.57 a	*2.40*
LSD	Sowing time: 0.026** Genotype: 0.020** Sowing time x Genotype: 0.042**					Sowing time: 0.035** Genotype: 0.041** Sowing time x Genotype: 0.080**				

Values with different letters within columns and rows differed significantly (**P<0.01); NS: Non-significant (P>0.05)

Table 4. Mean Cu, Zn, Mn and Fe contents (ppm) of narbon vetch genotypes under different sowing times

Genotype	Cu					Zn				
	Sowing time					Sowing time				
	1	2	3	4	Average	1	2	3	4	Average
Dikili	19.64 de	20.16 c	19.29 e	17.64 g	19.19 b	17.43 e	27.89 bc	37.66 a	27.07 bc	26.68
Bozdag	17.05 h	18.80 f	19.87 cd	20.69 b	19.09 b	20.12 de	34.12 a	23.54 cd	28.39 b	26.54
Özgen	18.67 f	17.51 g	21.13 a	20.87 ab	19.55 a	19.16 de	24.97 bc	26.59 bc	29.25 b	24.99
Average	18.45 d	18.81 c	20.10 a	19.73 b	*19.28*	18.90	28.99	28.15	28.23	*26.35*
LSD	Sowing time: 0.238** Genotype: 0.184** Sowing time x Genotype: 0.369**					Sowing time: 3.426** Genotype: NS Sowing time x Genotype: 4.400**				

Genotype	Mn					Fe				
	Sowing time					Sowing time				
	1	2	3	4	Average	1	2	3	4	Average
Dikili	57.32 g	69.56 e	77.10 ab	41.77 l	61.44 c	205.02 d	164.13 h	171.00 g	125.89 j	166.51 c
Bozdag	63.28 f	77.87 a	70.19 e	77.31 ab	72.16 a	189.00 e	150.50 l	230.00 a	190.00 e	189.87 a
Özgen	76.53 bc	50.54 h	75.89 c	72.95 d	68.98 b	186.50 f	111.94 k	219.00 b	210.50 c	181.99 b
Average	65.71 b	65.99 b	74.39 a	64.01 c	*67.52*	193.51 b	142.19 d	206.67 a	175.47 c	*179.46*
LSD	Sowing time: 0.498** Genotype: 0.400** Sowing time x Genotype: 0.802**					Sowing time: 2.214** Genotype: 0.916** Sowing time x Genotype: 1.832**				

Values with different letters within columns and rows differed significantly (**P<0.01); NS: Non-significant (P>0.05)

the development of grass tetany in some cows. If it decreases, the concentration of Mg in the cerebrospinal fluid falls more rapidly when Mg in the blood decreases, as absorption is insufficient (Ates, 2017). Allison (2003), Ates and Tekeli (2005) and Tenikecier and Ates (2019) reported earlier that 0.20-0.25% Mg in the dry matter of forage crops was a fairly safe level to prevent the likelihood of grass tetany, which was similar to the present findings.

Micromineral content: Mean values of Cu, Mn and Fe contents from the genotype, sowing time and interaction of genotype x sowing time were significantly different (Table 4). The highest Cu (20.10 ppm), Mn (74.39 ppm) and Fe (206.67 ppm) contents were found at 3rd sowing time. The Zn content was influenced significantly (P<0.01) by sowing time and genotype x sowing time interactions. The highest Zn contents of 34.12 and 37.66 ppm were obtained at 2nd and 3rd sowing times in genotypes Bozdag and Dikili, respectively (Table 4). However, microelement contents in hay of narbon vetch genotypes were not in toxic levels irrespective of sowing time. For example, sheep (*Ovis aries* L.) are very sensitive to Cu content of forage with maximum tolerable level of 25 ppm. It was emphasized that the microelement contents in quality forage legumes and grasses must be within the range of 35-50 and 20-40 ppm for Zn and Mn, respectively (Okuyan *et al*., 1986; Das *et al*., 2018; Singh *et al*., 2020). The nutrient contents of some vetch species were studied by Çelen *et al*. (2005), who reported that Fe, Cu, Zn and Mn contents were varied from 176.0 to 551.7 ppm, 5.73 to 9.15 ppm, 15.77 to 31.14 ppm and 42.01 to 59.22 ppm, respectively. However, the values obtained in the present study for Cu, Zn and Mn contents were comparatively higher.

Tetany ratio: The tetany ratio was influenced significantly ($P<0.01$) by genotype, sowing time and genotype x sowing time interactions. The tetany ratio was increased in all narbon vetch genotypes after 1st sowing time (Table 3). The lowest tetany ratios were obtained from genotypes Bozdag and Ozgen at first sowing time, whereas the highest tetany ratio (2.57) was obtained at 4th sowing time. There is high tetany risk in narbon vetch genotypes after first sowing time. When tetany ratio is higher than 2.2, the forage is classified as tetany-prone (Kvasnicka and Krysl, 2005). Tetany is a serious, often fatal metabolic disorder, characterized by low levels of Mg in the blood serum of cattle. It is also called grass staggers and wheat pasture poisoning. It primarily affects older cows nursing calves less than two months old, but it may also occur in young or dry cows and growing calves. It happens most frequently when cattle are grazing succulent, immature grass and often affects the best cows in the herd. High nitrogen fertilization reduces Mg availability, especially on soils high in K. Tetany occurs most frequently in the spring, often following the cool period (temperatures between 7 and 16 °C), when the grass is growing rapidly, but also it is seen in the fall with the new growth of the cool season grass. The prevention of tetany depends largely on avoiding conditions that cause it. The less susceptible animals should graze on high-risk pastures. Steers, heifers, dry cows, and cows with calves over 4-5 months old are less likely to develop tetany. The use of dolomite or high Mg limestone on pastures and including legumes in pasture mixes will decrease the incidence of tetany in grazing cattle. In areas where tetany frequently occurs, cows should be fed with supplemental Mg. Supplementation increases blood Mg levels and alleviates much of the tetany problem. Adequate amounts of Mg must be consumed on a daily basis (Tekeli *et al.,* 2003; Cherney *et al.,* 2002; Kvasnicka and Krysl, 2005). However, Turk *et al.* (2009) reported that the tetany ratios changed from 0.65 to 1.24 with maturity in hairy vetch (*V. villosa* Roth.) and there was no tetany risk in hairy vetch in spite of advanced plant maturity.

Conclusion

From the above study, it was concluded that the narbon vetch genotypes could be sown in the month of November, for appropriate cell wall components, low tetany risk, high herbage and hay yields in the northern hemisphere subtropical regions of the world. Based on herbage and hay yields, Ozgen and Dikili genotypes were found suitable and could be recommended for exploitation as potential fresh or dried forage resources of livestock.

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