Journal of Elementology ISSN 1644-2296

Tenikecier H.S. 2021.
Effect of a sowing date on the dry matter yield, tetany ratio, fiber and mineral content of two vetch species (Vicia sp.).
J. Elem., 26(4): 1011-1024. DOI: 10.5601/jelem.2021.26.3.2175

RECEIVED: 9 August 2021
ACCEPTED: 27 November 2021

ORIGINAL PAPER

EFFECT OF A SOWING DATE ON THE DRY MATTER YIELD, TETANY RATIO, FIBER AND MINERAL CONTENT OF TWO VETCH SPECIES (*VICIA* SP.)

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Abstract

The objective of this study was to evaluate the effect of a sowing date on the dry matter yield, tetany ratio, mineral and fiber content of two vetch species (Hungarian vetch and common vetch) and their newly developed varieties. This research was conducted during 2016-2018, at the Research and Experimental Area (40°59′25.2″ N, 27°34′48.4″ E), Field Crops Department, Faculty of Agriculture, Tekirdag Namik Kemal University, Turkey. It was set up in a randomized split block design with three replications. Certified seeds of the common vetch (Alper, Orakefe and Selçuk) and Hungarian vetch (Altınova, Ege Beyazı and Sarıefe) varieties were used. The dry matter yields of varieties from each vetch species decreased with the delay of a sowing date (from November to February). The highest dry matter yield was obtained from common vetch varieties Orakefe (7.08 Mg ha^{-1}) and Selçuk (6.98 Mg ha^{-1}) at 1^{st} sowing date (November). The delay of sowing dates (from November to February) resulted in an increase in the crude protein and fiber, neutral detergent fiber, acid detergent fiber and acid detergent lignin content. The highest P content (0.29%) was determined in Hungarian vetch variety Altınova at the first sowing date. The highest P content (0.44%) was obtained from common vetch variety Orakefe at 3^{rd} sowing date (January). The highest K content (2.28%) was recorded from Hungarian vetch varieties at 1^{st} sowing date. The lowest K content (2.61%) was obtained from common vetch varieties at same sowing date. The highest Ca (1.30%) and Mg (0.49%) contents of Hungarian vetch were found in variety Ege Beyazı at 4^{th} sowing date (February), the lowest tetany ratio (0.97) was calculated for the same variety and sowing date. The lowest Fe (82 mg kg^{-1} for Hungarian vetch variety Ege Beyazı, 107.50 mg kg^{-1} for common vetch variety Alper), Cu (17.78-14.90 mg kg^{-1} for Hungarian vetch varieties Ege Beyazı and Sarıefe, 15.17 mg kg^{-1} for common vetch variety Alper) and Mn (28.53-28.62 mg kg^{-1} for Hungarian vetch varieties Ege Beyazı and Altınova, 27.54 mg kg^{-1} for common vetch variety Orakefe) contents were recorded at 3^{rd}, 2^{nd} (December) and 1^{st} sowing dates, respectively. The lowest Zn content (14.12 mg kg^{-1}) was recorded from Hungarian vetch variety Ege Beyazı at 3^{rd} sowing date. Besides, the lowest Zn content (16.73 mg kg^{-1}) was obtained from common vetch variety Alper at 1^{st} sowing date.

Keywords: common vetch, dry matter yield, fiber content, Hungarian vetch, mineral content, tetany, *Vicia* sp.

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INTRODUCTION

The most important factor affecting the livestock of developing and less developed countries is the shortage of cheap, abundant, high-quality feedstuff. The feeding with low-quality forages, such as crop residues (triticale (× *Triticosecale* Wittm. ex A. Camus.), wheat (*Triticum* sp.), barley (*Hordeum vulgare* L.), straw or low-quality hay, with protein (meal) or energy supplementation (cereals) to wintering ruminants is a common practice in these countries. However, these low-quality forages may limit the performance of dairy and fast-growing beef cows due to their high gut-filling capacity. Dairy cows can only produce high milk yields and beef cows can only reach their maximum potential if their intermediary metabolism is supplied with sufficient nutrients. Thus, high-quality forages have to be produced (Bingol et al. 2007). There are about 150-190 vetch species (*Vicia* sp.), most of which are grown for this purpose in temperate regions of the Old World, covering Asia, Europe and Africa (Tenikecier, Orak 2020). The herbage, hay and seeds of vetch species are an important source of nutrients for ruminant livestock. Ruminant animals have the capacity to convert forage into meat, milk and wool, which are products desired by livestock breeders. Because alfalfa (*Medicago sativa* L.), clovers (*Trifolium* sp.) and vetches are fundamental to ruminant livestock production, it is necessary to produce alfalfa, clover and vetch varieties that continue to be high in quality and possess a minimum of anti-quality components (Ate, Servet 2004).

However, climate exerts a major influence on the growth of forage crops and other plants. Agricultural practices are often modified to suit the climate under which forage crops are grown. Climate is the principal factor influencing the adaptation of forage crops. Two factors, precipitation and temperature, play the major role in determining the climate of any region for sowing and harvesting of forage crops. Besides, the successful growth of various vetches is largely dependent on winter hardiness, precipitation and soil adaptability. Although most vetch species cannot survive in extreme temperature, vetches, usually considered as winter annuals, can be grown during the winter months in regions having mild winter temperatures (Kendir 1999). For example, Hungarian vetch (*V. pannonica* Crantz.) endures down to -17 to -18°C, and common vetch (*V. sativa* L.) withstands down to -12°C (Tekeli, Ates 2011). Herbage and hay yields of forage crops differ considerably from one year to another and also during the season, often as a result of differences in the weather during those years or season. But global climate changes are expected to affect the growth, forage yield and quality of vetches and other forage crops, and therefore we may need to change agricultural practices (seeding date, fertilization regime, irrigation time and amount, harvest time, etc.) to reduce the impact of unfavourable weather conditions (Tenikecier, Orak 2020). Therefore, the objective of this research was to evaluate the effect of a sowing date on the dry matter yield, tetany ratio, mineral and fiber contents of two vetch species (Hungarian vetch and common vetch) and their newly developed varieties.

MATERIALS AND METHODS

Study site and experimental design

This research was conducted during 2016-2018, at the Research and Experimental Area (40°59′25.2″ N, 27°34′48.4″ E), Field Crops Department, Faculty of Agriculture, Tekirdag Namik Kemal University, Turkey (Figure 1).

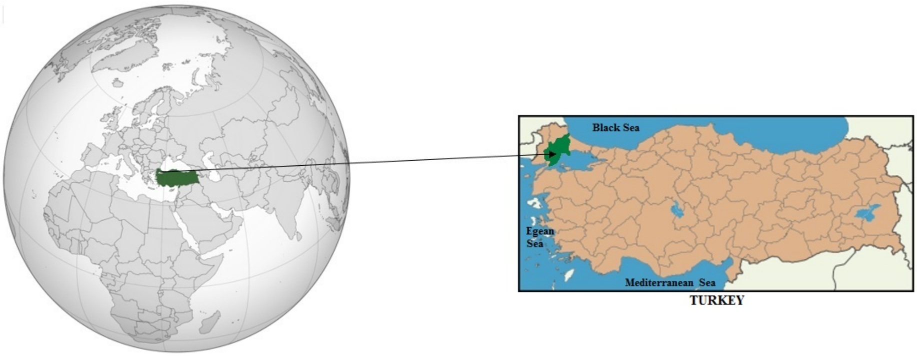

Fig. 1. Geographical location of the experimental area

It was set up in a randomized split block design with three replications. The total rainfall was 502.7 in 2016-2017 mm and 472.2 mm (6.01% less) in 2017-2018. The maximum rainfall was in November (107.4 mm) followed by January (107.0 mm). The mean temperature was 11.8°C during 2016-2017, while it was 13.9°C during 2017-2018. The soil in the experimental site was slightly alkaline 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 mg kg^{-1} and potassium (KO) content of 293 mg kg^{-1}.

Certified seeds of the common vetch (Alper, Orakefe and Selçuk) and Hungarian vetch (Altınova, Ege Beyazı and Sarıefe) varieties were used. Each plot consisted of 6 rows 25 cm apart and 5 m in length. The seeds of each varieties were sown in amounts of 80 kg ha^{-1} (for Hungarian vetch) and 100 kg ha^{-1} (for common vetch) on 20 November 2016 (1^{st} sowing date), 20 December 2016 (2^{nd} sowing date), 20 January 2017 (3^{rd} sowing date) and 20 February 2017 (4^{th} sowing date) during 2016-2017, and on 09 November 2017 (1^{st} sowing date), 12 December 2017 (2^{nd} sowing date), 01 January 2018 (3^{rd} sowing date) and 20 February 2018 (4^{th} sowing date) during 2017-2018. Seeds were sown with a manual seeder. In each year, basal fertilizer containing N and P (40 kg ha^{-1}) was incorporated into the soil during soil tillage (Ates, Tenikecier 2020). Weeds were controlled manually. To determine the dry matter yield, vetch plants were harvested at the pod formation stage of varieties from an area of 2.5 m^2 at 3 cm height above the ground (Ate, Servet 2004). Approximately 1 kg fresh forage samples from each variety were oven-dried at 70°C for 48 h, to determine dry matter and to calculate the yield (Mg ha^{-1}).

Chemical analyses

Dry samples were ground to small (≤1 mm) pieces and used for 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 (2019). 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, mg kg^{-1}), zinc (Zn, mg kg^{-1}), manganese (Mn, mg kg^{-1}) and iron (Fe, mg kg^{-1}) contents were measured on an atomic absorption spectrophotometer (ICP - OES, inductively coupled plasma-optical emission spectrometer) – Isaac, Johnson Jr (1998). Tetany ratios (K/Ca + Mg) were then calculated.

Statistical analyses

The means of characteristics of the varieties from the two years were compared separately for each species. The TARIST programme was used for the comparison of the means.

RESULTS AND DISCUSSION

The sowing dates affected dry matter yield, crude protein, cell wall components, macro- and micronutrient contents and tetany ratios of Hungarian and common vetch varieties (Tables 1-3). In addition, no differences between vetch varieties were observed in the dry matter, crude fiber and ADF contents for two-year means (P>0.05). On the other hand, the variety x sowing date interaction had an insignificant effect on the crude fiber content of the vetch varieties.

Dry matter yield

As shown in Table 1, the dry matter yields of varieties from each vetch species decreased with the delay of a sowing date (from November to February). The lowest dry matter yield of Hungarian (1.84 Mg ha^{-1}) and common (2.85 Mg ha^{-1}) vetches were obtained at 4^{th} sowing date. The variety x sowing date effect was significant for the dry matter yield of common vetch varieties (P<0.01). The highest dry matter yield was obtained from common vetch

Table 1

Effects of different sowing dates on dry matter yield, crude protein and fiber contents and cell wall components in common vetch and Hungarian vetch

Specification	Sowing Date	Hungarian vetch varieties				Common vetch varieties			
		Ege Beyazı	Sarıefe	Altınova	mean	Alper	Orakefe	Selçuk	mean[¥]
Dry matter yield (Mg ha^{-1})	1[st]	5.40	4.88	5.14	5.14*a*	5.87*b*	7.08*a*	6.98*a*	6.64*a*
	2[nd]	4.09	3.48	3.54	3.70*b*	5.02*c*	2.62*f*	4.00*d*	3.88*b*
	3[rd]	2.83	2.61	2.41	2.62*c*	3.88*d*	2.87*f*	3.73*de*	3.49*c*
	4[th]	1.81	2.03	1.68	1.84*d*	2.64*f*	2.95*ef*	2.95*ef*	2.85*d*
	mean[†]	3.53	3.25	3.19	*3.23*	4.35	3.88	4.41	*4.21*
	LSD	variety (V): NS sowing date (Sd): 0.340** V x Sd: NS				V: NS Sd: 0.324** V x Sd:0.807**			
Crude protein (%)	1[st]	13.72*b*	12.69*bc*	14.03ab	13.48b	15.04d	14.78d	17.28c	15.70c
	2[nd]	13.12*bc*	11.72cd	13.41b	12.75c	18.10bc	15.50d	15.50d	16.37b
	3[rd]	11.19*d*	13.56b	13.69b	12.81c	15.16d	19.35a	19.09ab	17.87a
	4[th]	14.00ab	15.22a	13.70b	14.31a	17.44c	17.09c	18.13bc	17.55a
	mean	13.00c	13.30b	13.71a	*13.34*	16.43b	16.68b	17.50a	*16.87*
	LSD	V: 0.100** Sd: 0.567** V x Sd: 1.414**				V: 0.557* Sd: 0.473** V x Sd: 1.180**			
Crude fiber (%)	1[st]	23.01	22.98	23.30	23.10d	21.33	21.40	21.73	21.48d
	2[nd]	23.53	23.73	23.78	23.68c	22.68	22.78	22.75	22.73c
	3[rd]	24.43	24.43	24.45	24.43b	23.40	23.35	23.55	23.43b
	4[th]	25.58	25.68	25.48	25.58a	24.45	24.45	24.63	24.51a
	mean	24.06	24.20	24.25	*24.20*	22.96	22.99	23.16	*23.04*
	LSD	V: NS Sd: 0.189** V x Sd: NS				V: NS Sd: 0.092** V x Sd: NS			
NDF (%)	1[st]	44.38e	44.58e	44.48e	44.48d	42.53f	42.45f	42.43f	42.47d
	2[nd]	45.60c	45.35d	45.45cd	45.47c	43.30e	43.53d	43.45d	43.43c
	3[rd]	46.63b	46.68b	46.55b	46.62b	44.03c	44.20b	44.23b	44.15b
	4[th]	48.45a	48.23a	48.28a	48.32a	45.78a	45.75a	45.70a	45.74a
	mean	46.26	46.21	46.19	*46.62*	43.91b	43.98a	43.95a	*43.95*
	LSD	V: NS Sd: 0.088** V x Sd: 0.223**				V: 0.036** Sd: 0.074** V x Sd: 0.133*			
ADF (%)	1[st]	33.14d	33.18d	33.30d	33.21d	30.10	30.25	30.23	30.19d
	2[nd]	33.74cd	33.68cd	34.15bc	33.86c	31.10	31.28	31.38	31.25c
	3[rd]	34.63ab	34.70ab	34.63ab	34.65b	31.55	31.75	31.68	31.66b
	4[th]	35.23a	35.25a	35.03a	35.17a	32.17	32.40	32.43	32.33a
	mean	34.18	34.20	34.28	*34.22*	31.23	31.42	31.43	*31.36*
	LSD	V: NS Sd: 0.128** V x Sd: 0.665**				V: NS Sd: 0.055** V x Sd: NS			
ADL (%)	1[st]	10.25*g*	10.05h	10.10gh	10.13d	9.10i	9.23h	9.20h	9.18d
	2[nd]	10.43*f*	10.45f	10.63e	10.50c	9.60g	9.80f	9.80f	9.73c
	3[rd]	11.00*cd*	11.08bc	10.88d	10.98b	10.28e	10.38d	10.39d	10.35b
	4[th]	11.28*a*	11.25ab	11.28a	11.27a	10.78c	11.05a	10.93b	10.92a
	mean	10.74	10.71	10.72	*10.72*	9.94b	10.11a	10.08a	*10.04*
	LSD	V: NS Sd: 0.099** V x Sd: 0.180*				V: 0.084** Sd: 0.045** V x Sd: 0.077*			

*, ** significant at 0.05 and 0.01 level, respectively. [¥] Sowing date means and variety x sowing date interactions with different letter fort the same column are significantly different. [†]Variety means with different letter for the same row are significantly different. NS – not significant

Table 2

Effects of different sowing dates on some macro-element contents and tetany ratio (K/Ca + Mg) in common vetch and Hungarian vetch

Specification	Sowing date	Hungarian vetch varieties				Common vetch varieties			
		Ege Beyazı	Sarıefe	Altınova	mean	Alper	Orakefe	Selçuk	mean[¥]
P (%)	1st	0.27b	0.24c	0.29a	0.27a	0.39bc	0.37bcd	0.37bcd	0.38a
	2nd	0.20f	0.21ef	0.20f	0.20c	0.34def	0.40b	0.31f	0.35c
	3rd	0.23cd	0.24c	0.22de	0.23b	0.32ef	0.44a	0.34def	0.37ab
	4th	0.24c	0.20f	0.18g	0.21c	0.35de	0.36cd	0.36cd	0.36bc
	mean[†]	0.23a	0.22b	0.22b	*0.22*	0.35b	0.39a	0.34b	*0.36*
	LSD	variety (V): 0.011** sowing date (Sd): 0.008** V x Sd: 0.017**				V: 0.038** Sd: 0.012** V x Sd: 0.031**			
K (%)	1st	2.35c	2.11d	2.39bc	2.28a	2.36k	2.80e	2.67g	2.61d
	2nd	1.68h	2.05e	1.71gh	1.81d	3.18a	2.63h	2.53j	2.78b
	3rd	2.08de	2.44a	1.85f	2.12c	2.60i	3.03c	2.53j	2.72c
	4th	1.74g	2.40ab	2.38bc	2.17b	2.84d	3.07b	2.78f	2.90a
	mean	1.96c	2.25a	2.08b	*2.10*	2.75b	2.88a	2.63c	*2.75*
	LSD	V: 0.080** Sd: 0.020** V x Sd: 0.049**				V: 0.019** Sd: 0.012** V x Sd: 0.009**			
Ca (%)	1st	1.09cd	1.20b	1.08cd	1.12a	0.96f	1.17c	1.18c	1.10c
	2nd	0.93ef	1.12c	0.93ef	0.99c	1.17c	1.21b	1.25a	1.21a
	3rd	0.80g	0.96e	1.07cd	0.94d	1.14d	1.16cd	1.18c	1.16b
	4th	1.30a	1.04d	0.87f	1.07b	0.97f	1.11e	1.17c	1.08d
	mean	1.03b	1.08a	0.99b	*1.03*	1.06c	1.16b	1.20a	*1.14*
	LSD	V: 0.039** Sd: 0.027** V x Sd: 0.068**				V: 0.015** Sd: 0.009** V x Sd: 0.025**			
Mg (%)	1st	0.30cde	0.36b	0.30cde	0.32b	0.20f	0.22e	0.25cd	0.23c
	2nd	0.26ef	0.33bc	0.26ef	0.28c	0.24d	0.26bc	0.26bc	0.25b
	3rd	0.28def	0.32bcd	0.25f	0.29c	0.24d	0.28a	0.27ab	0.26a
	4th	0.49a	0.29c-f	0.30cde	0.36a	0.22e	0.26bc	0.27ab	0.25b
	mean	0.33a	0.33a	0.28b	*0.31*	0.22b	0.25ab	0.26a	*0.24*
	LSD	V: 0.027** Sd: 0.017** V x Sd: 0.043**				V: 0.030** Sd: 0.008** V x Sd: 0.001**			
Tetany ratio (K/Ca+Mg)	1st	1.70d	1.35e	1.73cd	1.59b	2.05d	2.02d	1.87f	1.98b
	2nd	1.42e	1.42e	1.43e	1.42c	2.25b	1.79g	1.68h	1.91c
	3rd	1.93b	1.93b	1.41e	1.75a	1.89ef	2.11c	1.75g	1.92c
	4th	0.97f	1.81c	2.04a	1.61b	2.41a	2.25b	1.92e	2.19a
	mean	1.51b	1.62a	1.65a	*1.59*	2.15a	2.04b	1.80c	*2.00*
	LSD	V: 0.098** Sd: 0.039** V x Sd: 0.100**				V: 0.078** Sd: 0.018** V x Sd: 0.043**			

** significant at 0.01 level. [¥] Sowing date means and variety x sowing date interactions with different letter fort the same column are significantly different. [†]Variety means with different letter for the same row are significantly different.

Table 3

Effects of different sowing dates on some micro-element contents in common vetch and Hungarian vetch

Specification	Sowing date	Hungarian vetch varieties				Common vetch varieties			
		Ege Beyazı	Sarıefe	Altınova	mean	Alper	Orakefe	Selçuk	mean[¥]
Cu (mg kg^{-1})	1st	15.72ef	15.44g	15.78f	15.65c	16.42gh	16.14h	17.24d	16.60c
	2nd	14.90hi	14.78i	14.96h	14.88d	15.17j	18.93b	15.59i	16.56c
	3rd	15.59e	17.35c	19.60a	17.51a	16.61fg	21.10a	16.86ef	18.19a
	4th	19.20b	16.75d	15.43g	17.13b	17.15de	18.17c	17.19de	17.50b
	mean[†]	16.35a	16.08b	16.44a	*16.29*	16.34b	18.59a	16.72b	*17.22*
	LSD	variety (V): 0.176** sowing date (Sd): 0.053** V x Sd: 0.133**				V: 0.421** Sd: 0.149** V x Sd: 0.372**			
Zn (mg kg^{-1})	1st	18.90d	17.95e	18.80d	18.55b	16.73i	16.19j	17.02h	16.64d
	2nd	16.37fg	16.41fg	16.50f	16.43c	19.88e	31.11a	24.37c	25.12a
	3rd	14.12i	15.44h	16.22g	15.26d	30.20b	21.75d	19.56f	23.84b
	4th	30.62a	23.00b	20.18c	24.60a	18.85g	20.05e	19.04g	19.31c
	mean	20.00a	18.19b	17.92c	*18.70*	21.41b	22.27a	20.00c	*21.23*
	LSD	V: 0.226** Sd: 0.081** V x Sd: 0.197**				V: 0.100** Sd: 0.096** V x Sd: 0.235**			
Mn (mg kg^{-1})	1st	28.53i	38.11d	28.62i	31.75d	36.40f	27.54i	60.10a	41.35a
	2nd	29.72h	39.21bc	29.93gh	32.95c	40.03d	38.13e	43.30c	40.48b
	3rd	31.59f	35.58e	40.40b	35.86b	43.77b	43.05c	34.80g	40.54b
	4th	45.58a	38.70cd	30.77fg	38.35a	28.77h	36.47f	36.32f	33.85c
	mean	33.85b	37.90a	32.43c	*34.73*	37.24b	36.30c	43.63a	*39.06*
	LSD	V: 0.496** Sd: 0.349** V x Sd: 0.870**				V: 0.264** Sd: 0.160** V x Sd: 0.400**			
Fe (mg kg^{-1})	1st	103.21h	150.70a	101.91h	118.64c	170.30c	152.35d	144.74f	155.80a
	2nd	123.15e	124.55e	128.18d	125.29b	110.36h	175.43b	146.00e	143.93b
	3rd	82.00i	115.90f	108.00g	101.97d	107.50i	197.00a	104.50j	136.34c
	4th	142.70b	137.02c	128.00d	135.91a	104.00j	144.00f	119.50g	122.50d
	mean	112.79c	132.04a	116.52b	*120.45*	123.04c	167.20a	128.68b	*139.64*
	LSD	V: 1.304** Sd: 0.733** V x Sd: 1.826**				V: 0.965** Sd: 0.381** V x Sd: 0.949**			

** significant at 0.01 level. [¥] Sowing date means and variety x sowing date interactions with different letter fort the same column are significantly different. [†]Variety means with different letter for the same row are significantly different.

varieties Orakefe (7.08 Mg ha^{-1}) and Selçuk (6.98 Mg ha^{-1}) at 1st sowing date. Dry matter is an indicator of the amount of nutrients that are available to the animal in a particular feed. Therefore, a high dry matter yield is very important. Livestock need to consume a certain amount of dry matter per day (measured in lbs. or kg day^{-1}) to maintain health and production. The daily amount of dry matter needed depends upon several factors, including weight and stage of production (e.g., lactating, pregnant, weaning, finishing) – CCOF (2020). Similarly, dry matter yields of different vetch species ranged from 1.36 to 9.35 Mg ha^{-1} (Sayar, Han 2014, Seydosoglu et al. 2014, Kebede 2018, Tenikecier, Orak 2020), whereas Kaplan et al. (2017) observed that this yield varied only from 0.20 to 0.35 Mg ha^{-1}.

CP and cell wall components

The delay of sowing dates (from November to February) resulted in an increase in the CP, CF, NDF, ADF and ADL contents (Table 1). The highest CP content for Hungarian vetch varieties (14.31%) was recorded at 4th sowing date. The highest CP contents for common vetch (17.55-17.87%) were recorded at 3rd and 4th sowing dates. The CP content of Hungarian vetch variety Sarıefe (15.22%) was significantly higher at the forth than at the other sowing dates. The highest CP content was obtained from common vetch variety Orakefe at 3rd sowing date (19.35%). The CP values are in agreement with the values reported in the literature (Bingol et al. 2007, Semmana et al. 2019). The CF content was influenced significantly by a sowing date whereas the NDF, ADF and ADL contents of Hungarian vetch varieties were affected significantly by a sowing date and the variety x sowing date interaction (P<0.01). The ADF contents of common vetch varieties were not affected by a variety and the variety x sowing date interaction (P>0.05), whereas the NDF and ADL contents of common vetch varieties were influenced by a variety, sowing date and the variety x sowing date interaction. The lowest CF contents (23.10 % for Hungarian vetch, 21.48% for common vetch) were found at the first sowing date. The forth sowing date had the highest NDF (common vetch: 45.74%, Hungarian vetch: 48.32%), ADF (common vetch: 32.33%, Hungarian vetch: 35.17%) and ADL (common vetch: 10.92%, Hungarian vetch: 11.27%) contents among all sowing dates. Constituents of forage can be divided into two classes, those of a concentrate nature and less digestible fibrous components. The highly digestible fraction, called the cellular content, includes protein, sugar, starch and organic acids. All forages contain some of these constituents, but not as much as concentrates when expressed as a total percentage of the feed. The cellular content is not inferior in quality to its concentrate counterparts. The other major fraction is that of the fibrous or cell wall components that are characteristics of forage as a class of feeds. The plant cell wall is the structural part of the plant and represents the total fibrous fraction (Van Soest 1973, Ates 2017). The quality of vetches and fodder pea (*Pisum arvense* L.) might be considered as a characteristic feeding value in nutrition of ruminant and non-ruminant animals. The feeding value can be measured in terms of production of meat, milk or wool. Forage, especially vetches and fodder pea, may supply from 10 to 99% of the required protein and 15 to 100% of the required energy for ruminant and non-ruminant animals, depending on the type of animal and season of the year (Tenikicier, Ates 2021). The requirement of a 500 kg beef cattle (*Bos taurus* L.) of superior milking ability nursing a calf the first 3 to 4 months postpartum is a minimum of 28.6 Mcal of digestible energy (NRC 2001). These requirements can be satisfied with 11.8 kg of DM (Essig 1985) from forage legumes. Daily intake of digestible DM is more closely correlated with DM intake than with DM digestibility. In most forage crops, the cell wall components account for 55-85 percent of DM. These components of forage crop species are affected by the many factors mentioned above (Tenikecier, Ates 2018). Young plant cells have the primary cell wall, but as they mature the secondary cell wall develops. This causes mature plants to be more fibrous (Arzani at al. 2004). ADF, NDF and ADL contents increased with the advancing plant growth. This could be explained by a decrease in the proportion of leaves and an increase of the proportion of stems with advanced maturity. The trend in ADL, ADF and NDF contents with progressing maturity is normally the reverse of protein (Yuksel, Turk 2019). Forage grasses are higher in NDF, ADF and ADL at a given stage of growth than forage legumes. The quality of forage crops is best estimated by their potential dry matter intake and dry matter digestibility, which are determined by the NDF and ADF fractions, respectively. Both NDF and ADF increase as the plant matures, causing a decline in the quality of the forage (Ates, Tenikecier 2019). Herdt (2014) recommended that the minimum NDF concentrations in diets for high-yielding cows are 25-30%. ADF and NDF ratios were reported respectively as between 21.5-40.5% and between 32.3-54.3% (Cacan et al. 2019). Orak et al. (2004) reported 18.05% CP and 12.15% crude fiber contents in hay from Hungarian vetch. Akdeniz et al. (2018) stated that CP varied from 26.27 to 28.17%, NDF varied from 34.78 to 40.09%, ADF varied from 12.22 to 15.16% and ADL varied from 2.81 to 3.65%, in hairy vetch (*V. villosa* Roth.). Ates (2021) obtained the values of 19.31 to 20.96% for CP, 21.45 to 23.14% for ADF and 32.16 to 34.07% for NDF in DM of different clover species. Current findings were similar with those earlier ones.

Macronutrient content and tetany ratio

There were significant differences in effects of a variety, sowing date and variety x sowing date interactions on the P, K, Ca, Mg content and tetany ratio ($P<0.01$, Table 2). The highest P content (0.29%) in Hungarian vetch was determined for variety Altınova at the first sowing date. The highest P content (0.44%) in common vetch was obtained from variety Orakefe at 3rd sowing date. The highest K content (2.28%) for Hungarian vetch varieties was recorded at 1st sowing date. The lowest K content (2.61%) for common vetch varieties was obtained at the same sowing date. The highest Ca (1.30%) and Mg (0.49%) content in Hungarian vetch was found in variety Ege Beyazı at the 4th sowing date, and the lowest tetany ratio (0.97) was calculated for the same variety and sowing date. In common vetch, the highest Ca content (1.25%) was determined in variety Selcuk at 2nd sowing date, and the lowest Mg content (0.20%) in the variety Alper at 1st sowing date. At 4th sowing date, the tetany ratio (2.41) of variety Alper was the highest.

The elements K, Ca, P, Mg, sulfur (S), sodium (Na) and chlorine (Cl) are present in the animal body at concentration ≥400 mg kg^{-1} body weight (BW), and are therefore called macro-minerals (Wu 2018). These seven macro-minerals and other 16 micro-minerals, i.e. Cu, Zn, Mn, Fe, cobalt (Co), iodine (I), selenium (Se), molybdenum (Mo), chromium (Cr), fluorine (F), tin (Sn), vanadium (V), silicon (Si), nickel (Ni), boron (B), and bromine (Br), are classified as nutritionally essential for ruminant and non-ruminants. Suttle (2010) reported that mineral deficiencies cause species-specific symptoms, such as reduced feed intake, growth retardation, impaired development, and even death. For example, a low concentration of Mg^{2+} in the brain or cerebrospinal fluid (< 0.25 mM) causes the NMDA receptors to be activated by glutamate and aspartate, and reduces the threshold at which neurons repetitively fire nerve impulses (action potentials), resulting in nervous disorders and consequently in tetany. However, the potassium deficiency syndrome includes muscle weakness, spasms, tetany, paralysis, numbness (particularly in legs and hands), excessive loss of body water (due to the inability to concentrate urine), low blood pressure, frequent urination, and thirst in animals. Finally, hypokalemia can also cause cardiac rhythm abnormalities, cardiac arrest, and even death in animals (Wu 2018). Tetany or hypomagnesemic tetany 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 a cool period (temperatures between 7 and 16°C), when the grass is growing rapidly, but it is also 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. 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 (Kvasnicka, Krysl 2009, Ates 2017). Besides, when the tetany ratio (with concentrations expressed as % diet DM) is greater than 2.2, precautions against tetany are necessary. NRC (2001) reported that the demand for major mineral nutrients for gestating beef cows or lactating beef cows is 0.6-0.8% (w/w) for K, 0.1-0.4% for Ca, 0.1-0.4% for P and 0.04-0.1% for Mg. Arnold, Lehmkuhner (2014) stated that the agronomic practices to reduce the risk of tetany include adding legumes to pasture mixes and the conservative application of N and K fertilizers that are aligned with needs based on soil tests. Nevertheless, hay feeding is an important control measure in herds where hypocalcemia precipitates grass tetany in hypomagnesemic ruminants. Tenikecier, Orak (2020) reported that the tetany ratio, P, K, Ca and Mg contents in narbon vetch (*Vicia narbonensis* L.) genotypes varied from 2.03 to 2.67, 0.30 to 0.41%, 1.72 to 2.73%, 0.83 to 1.25% and 0.20 to 0.44%, respectively, which resembled the present findings. Turan et al. (2020) determined that the tetany ratios of common and hairy vetches ranged from 3.90 and 4.47, respectively, which was higher than the present findings.

Micronutrient content

The lowest Fe (82 mg kg^{-1} for Hungarian vetch variety Ege Beyazı and 107.50 mg kg^{-1} for common vetch variety Alper), Cu (17.78-14.90 mg kg^{-1} for Hungarian vetch varieties Ege Beyazı and Sarıefe, 15.17 mg kg^{-1} for common vetch variety Alper) and Mn (28.53-28.62 mg kg^{-1} for Hungarian vetch varieties Ege Beyazı and Altınova, 27.54 mg kg^{-1} for common vetch variety Orakefe) contents were recorded at 3rd, 2nd and 1st sowing dates, respectively (P<0.01, Table 3). The lowest Zn content (14.12 mg kg^{-1}) was recorded for Hungarian vetch variety Ege Beyazı at 3rd sowing date. However, the lowest Zn content (16.73 mg kg^{-1}) was obtained from common vetch variety Alper at 1st sowing date. The Fe, Cu, Zn and Mn required by the animal are described as essential microelements because they are required in quantities of mg day^{-1}, rather than g day^{-1}, which is the case of Ca, Mg, P and K. There is seasonal variation in the availability of Cu from pastures. In Australia for example, it is generally less available from the lush green feed in winter and spring in the Mediterranean climate of southern Australia, and after the summer rainfalls in the north, than from dry feed. Suttle (2010) suggest that marginal bands for the Cu concentration (mg kg^{-1} DM) in the diet are 12-36 for sheep, 100-300 for cattle and 30-100 for goats. The demand for Fe given by several reports is 30-40 mg Fe kg^{-1} DM, the higher value applying to calves of less than 150 kg in weight and to pregnant and lactating cows and ewes. Wu (2018) stated that the leguminous plant species (*Fabaceae* sp.) have more iron (200-400 mg kg^{-1} on a dry matter basis) than grasses (*Poaceae* sp.) (~40 mg kg^{-1}), which was higher than the present findings. However, the bioavailability of iron from plant feed is low for mammals, birds, and fish (Haider et al. 2018). The nutrient contents of some vetch species were studied by Celen et al. (2005), who reported that Fe, Cu, Zn and Mn contents varied from 176.0 to 551.7 mg kg^{-1}, 5.73 to 9.15 mg kg^{-1}, 15.77 to 31.14 mg kg^{-1} and 42.01 to 59.22 mg kg^{-1}, respectively. Das et al. (2018), Singh et al. (2020), Tenikecier, Orak (2020) emphasized that the microelement contents in quality forage legumes and grasses must be within the range of 17.43-50.0 and 20.0-77.7 mg kg^{-1} for Zn and Mn, respectively. The present findings were similar to those reported by these researchers.

CONCLUSION

It was concluded that the common vetch and Hungarian vetch varieties could be sown in the northern hemisphere subtropical regions of the world in the months of November (1st sowing date) and December (2nd sowing date), for appropriate cell wall components, low tetany risk, high dry matter yield and P, K, Ca contents. Based on dry matter yield, all of the Hungarian vetch varieties and Orakefe and Selçuk common vetch varieties were found suitable and could be recommended for cultivation as potential dried forage resources of livestock.

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