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THE FACTORS AFFECTING YIELD AND QUALITY OF HUNGARIAN VETCH+CEREAL MIXTURES IN ARID ENVIRONMENTAL CONDITIONS

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ABSTRACT

This study was carried out to determine the performances of pure sowing of Hungarian vetch (HV) (*Vicia pannonica Crantz*), barley (*Hordeum vulgare* L.), triticale (T) (XTriticosecale Wittmack) and their mixtures with HV in arid conditions during 2012-2013 and 2013-2014 vegetation seasons. The experiment was designed based on split plots in a randomized block design with four replicates. Three different cutting times of pure sowing and mixtures were determined as booting, flowering and milk dough stages. Vetches were at 10% flowering when cereals were in booting stage, the vetches were in full flowering while the cereals were in flowering stage, while the lower pod-setting of vetches, the cereals were in milking dough stage. The pure sowing vetch was also harvested during these periods. The highest wet and dry hay yields, considering the mixture and cutting time separately, were obtained at the milk dough stage from the mixture of 25% HV + 75% T. The crude protein ratio increased with the increase in HV ratio of mixtures while the ratios of ADF and NDF decreased. The extend of cutting time from booting to milk dough stage increased the hay yield while quality traits were decreased. The superior yield and quality traits of annual legume + cereal mixtures, when evaluated along with cutting time, suggested that harvesting of 50% HV+50% T mixture can be recommended during flowering period.

KEYWORDS:
Hungarian vetch, Cereal, Mixture, Cutting time, Yield, Quality

INTRODUCTION

Vetch species, high quality leguminous of forage crops are widely found in the flora of Turkey, but also cultivated in different climate and ecological conditions [1]. The Hungarian vetch (*Vicia pannonica* Crantz), which is very resistant to drought and winter frost among vetch species, is an annual legume forage crop that is not affected by late spring and early summer rainfall instabilities [2]. Lodging due to the weakness of stem in vetch species results in reducing the yield and quality of hay as well as complicates the harvesting process [3, 4] The vetches should be planted as mixed with cereals to solve this problem. The steep habitus of cereals when planted mixed with vetches prevents vetches from lodge, decay and leaf loss and facilitates the harvest. Mixtures with compatible species are more efficient than pure sowing of the same species [5, 6]. The triticale is more resistant to drought and cold, and taller and has bigger spikes than other cereals [7]. Barley has advantages of growing in almost all regions of the country, adaptation to different environmental conditions and suppressing weeds by fast development [8]. Cultivation of Hungarian vetch mixed with triticale and barley results in higher hay yield due to efficient use of environmental resources by plants in the mixture [6]. The forage quality of cereals is low though the yield is high. However, legumes produce low dry matter yield and known to have high feed quality. Therefore, combination of legumes with cereals is ideal to obtain high yield and quality of forage production [9].

Increasing the forage production with high feeding value will lead to an increase in the yield of animal products in a short-term. Annual wheat-legume mixtures have an important role in meeting the quality forage demand of livestock farms. Legumes have higher protein and lower ADF and NDF contents than cereals. Forage quality improves when the ratio of legumes in pure sowing and mixture increases [10]. Cutting time is another factor determining the quality of forage. Early cutting improves the protein and digestible dry matter ratio while reduces forage quality depending on maturation of the plant [11, 12]. Therefore, determining suitable plant species as well as optimum mixing ratios and cutting time are extremely important to benefit from the intercropping [5, 6, 13].

This study was aimed to determine the optimum Hungarian vetch and cereal mixture ratio and appropriate cutting time to provide high yield and quality forage in region.

TABLE 1
Climate data for the growing seasons that the study was conducted

	Average Temperature (°C)			Total Precipitation (mm)		
Months	2012-2013	2013-2014	Long years	2012-2013	2013-2014	Long years
October	14.7	10.3	12.8	59.3	20.5	35.1
November	7.4	7.7	6.4	41.7	40.0	37.2
December	3.3	-2.1	2.1	90.1	10.4	43.8
January	1.2	1.9	0.4	29.1	46.2	42.7
February	4.4	4.2	1.5	39.4	23.4	32.2
March	7.1	7.3	5.6	14.2	52.2	35.7
April	11.8	13.1	10.8	46.2	20.0	48.8
May	18.0	16.3	15.9	15.1	46.6	40.3
June	21.4	19.9	20.3	1.0	36.0	32.6
Average/Total	9.9	8.7	8.4	336.1	295.3	348.4

MATERIALS AND METHODS

A field experiment over 2012-2013 and 2013-2014 growing seasons was conducted at the Ahi Evran University Bağbaşı Campus (1090 above sea level, 39° 08' N and 34° 06' E) under arid conditions. Soils in study area were clay loam, non-saline (0.02%), highly calcareous (27.90%), low in organic matter (1.81%) and available phosphorus (2.14 kg da^{-1}), slightly alkaline and rich in potassium (66.6 kg da^{-1}).

Average monthly temperature values during the first (October 2012-June 2013) and second (October 2013-June 2014) growing seasons, except for October and December, were higher than the long-term average temperature values (Table 1). Total precipitations during growing seasons were lower than the long-term average precipitation. The precipitations in October, November and December of the first growing season and March, May and June of the second growing season were higher compared to those months in the long-term data.

The plant materials used were Altınova-2002 Hungary vetch (*Vicia pannonnica* Crantz), Tarm-92 barley (*Hordeum vulgare L.*) and Tatlıcak-97 triticale (XTriticosecale Wittmack) species. pure sowing of Hungary vetch (HV), barley (B), triticale (T) and six mixtures of HV with B and T were the treatments of the study. The seeding ratio of mixtures were 75% HV+25% B, 50% HV+50% B, 25% HV+75% B, 75% HV+25% T, 50% HV+50% T and 25% HV+75% T. The seeding rates for pure sowing of HV was 220 seed m^{-2} [14], T and B were 500 seed m^{-2} [15]. The seeds were sown in 10 rows by hand in October 21, 2012 and October 29, 2013 in the first and second growing seasons, respectively. The row spacing was 20 cm and the length of rows was 5 m. The seeds were mixed and sown together in intercropping. Nitrogen and phosphorus at 4 and 10 kg da^{-1}, respectively, were applied as diammonium phosphate fertilizer into the soil before sowing. The experimental design was split plots in randomized blocks with four replications. Cutting times were placed in main plots and mixture rates were in sub plots. Three different cutting times were determined as booting (B1), flowering (B2) and milk dough (B3) stages. Vetches were at 10% flowering when cereals were in booting stage, the vetches were in full flowering while the cereals were in flowering stage, while the lower pod-setting of vetches, the cereals were in milking period. The pure sowing vetch was also cutting during these periods. Crops were cutting at May 09, 2013, May 22, 2013 and May 30, 2013 in the first year and May 18, 2014, June 02, 2014 and June 12, 2014 in the second year. A row from each side of the plots, 50 cm distance from the head and end of plots were not cutting due to the side effect [8]. The rest of plants in plots were cut by using a scythe, weighed and green forage yields were determined. The samples of 500 g green forage from each plot were dried at 60 ºC to the constant weight and dry hay yields were calculated [16]. Total N contents of species and mixtures were determined using the Kjeldahl method and crude protein ratios were calculated by multiplying the N content by 6.25 [17]. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined using the ANKOM200 Fiber analysis instrument [18]. Digestible dry matter rates (DDMR) were estimated using ADF values according to following equation described by Sheaffer, Peterson [19]. The digestible dry matter yields were calculated by multiplying DDMR by hay yields.

Digestible Dry Matter Rate (DDMR) = 88.9 – (0.779 x ADF%, dry matter basis)

The MSTAT-C statistical software was used to conduct the analysis of variance for the results obtained in the experiment. Duncan for multiple comparisons and the least significant difference (LSD) test for paired comparisons were used [20].

RESULTS AND DISCUSSION

Green Forage Yield. The highest green forage crop (1677.1 kg da^{-1}), according to two year averages was obtained from 25% HV+75% T mixture and the lowest yield (968.7 kg da^{-1}) was obtained from pure sowing Hungary vetch (Table 2). The green forage yield of Hungary vetch and triticale mixture was higher than that of mixture with barley. Despite the lower tillering of triticale, the taller plant height and larger spike sizes compared to barley increases the yield of green forage [21]. Similarly, Varughese, Barker [22] have also reported higher green forage yield for triticale as compared to barley. The increase in proportion of cereal seeds in mixture has increased the green forage yield. In other words, the decline in Hungary vetch ratio in the mixture has increased the green forage yield. Spring rainfall has contributed to the rapid growth of cereals, which has led to an increase in competitiveness of cereals and ultimately increased the yields of cereals. Spring rainfall has contributed to the rapid growth of cereals, which has led to a rise in competitiveness of cereals and resulted in an increase yields of cereals. The weak and scrambling nature of Hungary vetch stem and tendency to lodge complicate the harvest and reduce the hay yield due to rotting and leaf loss [2, 23]. Therefore, the lowest green forage yield was obtained from pure sowing Hungary vetch in both seasons of the study. The green forage yield, cutting based on ripening periods of cereals increased from in booting (1240.8 kg da^{-1}) to flowering (1409.0 kg da^{-1}) and milk dough (1501.3 kg da^{-1}) stages. Plants, with prolongation of the vegetation period, continues to assimilate and grow and crop yield increases as the progress of growing stages [24]. The cutting times affected the green forage yields at different levels, causing significant variations in green forage yields of pure sowing and mixtures ($p<0.01$). The interaction of cutting time x treatment was found important.

Delaying the cutting from 10% flowering to full flowering significantly increased the green forage yield, however cutting in the full flowering stage did not result in a statistically significant increase in green forage yield. On the other hand, the green forage yields of pure sowing barley cutting in booting and milking dough stages were not statistically different. The green forage yield of pure sowing triticale was significantly increased with the progress of the vegetation period.

The average green forage yields of Hungary vetch and barley mixtures and pure sowing barley were not significantly different in the first year of the experiment. The green forage yield of 75% HV+25% B mixture was significantly lower in the second year of the study than the pure sowing barley and the rest of the barley and Hungary vetch mixtures. This result made the year x treatment interaction important.

The effect of year on cutting time was significantly different, which made year x cutting time interaction statistically significant ($p<0.01$). Delaying the cutting from booting to flowering stage of cereal significantly increased the average green forage yield in the first year of the experiment. However, delaying the cutting to flowering stage did not result in a statistically significant difference in the mean green forage yield. In the second year, average green forage yield in delaying the cutting from flowering stage to milk dough stage was higher compared to that of flowering stage.

Hay Yield. The highest hay yield in two-year averages was obtained with 25% HV+75% T and pure sowing triticale (Table 2). The average hay yield in pure sowing vetch plots was significantly lower than yield obtained in the mixtures and pure sowing triticale and barley plots. Similarly, Hatipoğlu, Anlarsal [25] have also stated that cereals had a higher carbohydrate ratio with higher levels of dry matter than legumes and showed a stronger development compared to legumes. The highest hay yield was obtained in milk dough stage of cereals and lower pod-setting stage of vetches, while the lowest hay yield was obtained in booting stage of cereals and 10% flowering stage of vetches. Young and water-rich cells were replaced by thickened and water-reduced cells with the progress of the vegetation period [26, 27]. Thus, dry hay yields also increased with the increase in dry matter content.

Time dependent change of competition within species for pure sowing and change within and among species for mixtures resulted in a significant ($p <0.01$) treatment x cutting time interaction. The pure sowing triticale, parallel to the green forage yield, was the emerged treatment in the first cutting time, while 25% HV + 75% T mixture was the prominent treatment in the second and the third cutting times.

The species x treatment interactions in both years were significant ($p<0.01$) due to the differences in the effects of species and mixtures on hay yield. The hay yield obtained from 25% HV+75% T mixture was significantly higher than that of 50% HV+50% T, whereas no statistically significant difference was observed between the hay yield both mixtures in the second year.

The average hay yields of the first year in the flowering and milk dough stages were significantly lower than those of the second year. This resulted in significant ($p<0.01$) year x cutting time interaction due to the effect of cutting time on hay yield depending on growing year.

Crude Protein Ratio. The highest crude protein ratio of two-year average was obtained from pure sowing Hungary vetch (18.8%), while the lowest ratio was with pure sowing barley (9.7%) (Table 3). The crude protein ratio increased with the increase in Hungarian vetch ratio of triticale and barley mixtures of Hungary vetch. The results agree with Acar, Gulumser [28] who reported higher crude protein ratio with the increase in legume ratio of legume + cereal mixtures compared to cereals alone. Similar data on higher crude protein content with higher

TABLE 2
Average Green Forage and Hay Yields of Species and Mixtures Investigated

	Green Forage Yield (kg da^{-1})				Hay Yield (kg da^{-1})			
	Cutting Time			Mean	Cutting Time			Mean
Treatments	Booting	Flowering	Milk Dough		Booting	Flowering	Milk Dough	
2013								
Pure Sowing HV	869.2 l**	964.9 kl	1026.3 jk	953.5 d**	217.6 p**	268.5 o	315,0 l-o	267.0 g**
Pure Sowing B	1329.0 e-ı	1324.2 e-ı	1288.5 e-ı	1313.9 c	329.1 k-n	374.1 h-k	429.3 d-g	377.5 e
Pure Sowing T	1505.0 cd	1631.4 bc	1731.0 ab	1622.5 a	429.8 d-g	523.1 b	621.8 a	524.9 a
%25 HV + %75 B	1339.7 e-h	1296.3 e-ı	1336.9 e-h	1324.3 c	326.7 k-n	385.3 g-j	416.7 f-h	376.2 e
%50 HV + %50 B	1258.9 g-ı	1251.4 hı	1441.4 d-f	1317.2 c	305.7 m-o	362.9 ı-l	452.9 c-f	373.8 ef
%75 HV + %25 B	1166.8 ıj	1275.1 f-ı	1287.9 e-ı	1243.3 c	284.6 no	350.5 j-m	406.9 f-ı	347.3 f
%25 HV + %75 T	1423.3 d-g	1694.9 ab	1830.8 a	1649.7 a	371.5 h-k	502.3 bc	593.4 a	489.1 b
%50 HV + %50 T	1363.8 d-h	1644.5 bc	1726.9 ab	1578.4 a	342.1 j-m	480.7 b-d	506.8 b	443.2 c
%75 HV + %25 T	1326.8 e-ı	1449.9 de	1455.8 de	1410.8 b	337.2 j-m	430.0 e-g	477.5 b-e	414.9 d
Mean	1286.9 b**	1392.5 a	1465.4 a	1379.3	327.1 c**	408.6 b	468.9 a	401.6
LSD (0.05)	CT:73.24, T:82.43, T x CT: 142.8				CT: 24.69, T:26.82, T x CT: 46.45			
2014								
Pure Sowing HV	847.8 n**	1003.5 m	1100.3 lm	983.9 e**	193.4 l**	288.3 ıj	343.3 hı	274.9 e**
Pure Sowing B	1261.1 I-l	1420.4 f-ı	1342.7 g-j	1341.4 c	293.3 ıj	441.6 de	463.2 c-e	399.4 c
Pure Sowing T	1352.5 g-j	1413.3 f-j	1582.1 d-f	1449.3 b	363.3 gh	454.2 c-e	546.3 b	454.6 b
%25 HV + %75 B	1232.6 j-l	1302.6 ıjk	1498.9 e-h	1344.7 c	271.2 jk	411.3 e-g	483.6 cd	388.7 c
%50 HV + %50 B	1158.2 k-m	1354.4 g-j	1515.1 e-g	1342.6 c	259.3 jk	427.9 d-f	505.8 bc	397.7 c
%75 HV + %25 B	1011.4 m	1328.5 h-k	1358.3 g-j	1232.8 d	222.9 kl	379.9 f-h	448.5 de	350.5 d
%25 HV + %75 T	1374.9 g-j	1733.5 cd	2004.8 a	1704.4 a	333.9 hı	547.4 b	653.4 a	511.6 a
%50 HV + %50 T	1238.9 ı-l	1758.3 bc	1894.9 ab	1630.7 a	299.6 ıj	557.0 b	613.6 a	490.1 a
%75 HV + %25 T	1275.1 I-k	1515.0 e-g	1601.3 c-e	1463.8 b	301.4 ıj	481.5 cd	545.1 b	442.7 b
Mean	1194.7 c**	1425.5 b	1544.3 a	1388.2	282.0 c**	443.3 b	511.4 a	412.2
LSD (0.05);	CT:72.74, T:88.23, T x CT:152.8				CT: 24.95, T:28.48, T x CT:49.33			
Mean								
Pure Sowing HV	858.5 k**	984.3 j	1063.3 j	968.7 g**	205.5 o**	278.4 mn	329.2 kl	271.0 f**
Pure Sowing B	1295.1 g-ı	1372.3 e-h	1315.6 f-ı	1327.7 e	311.2 l-m	407.8 h	446.3 fg	388.5 d
Pure Sowing T	1428.8 d-f	1522.3 d	1656.6 c	1535.9 c	396.5 hı	488.7 c-e	584.0 b	489.7 a
%25 HV + %75 B	1286.1 hı	1299.4 g-ı	1417.9 d-g	1334.5 e	298.9 lm	398.3 hı	450.2 fg	382.5 d
%50 HV + %50 B	1208.6 ı	1302.9 g-ı	1478.3 de	1329.9 e	282.5 mn	395.4 hı	479.3 d-f	385.8 d
%75 HV + %25 B	1089.1 j	1301.8 g-ı	1323.1 f-ı	1238.0 f	253.8 n	365.2 ıj	427.7 gh	348.9 e
%25 HV + %75 T	1399.2 e-h	1714.3 bc	1917.8 a	1677.1 a	352.7 jk	524.9 c	623.4 a	500.3 a
%50 HV + %50 T	1301.4 g-ı	1701.4 c	1810.9 b	1604.6 b	320.9 kl	518.9 c	560.2 b	466.7 b
%75 HV + %25 T	1300.9 g-ı	1482.5 de	1528.5 d	1437.3 d	319.3 kl	455.7 e-g	511.3 cd	428.8 c
Mean	1240.8 c**	1409.0 b	1501.3 a	1383.7	304.6 c**	425.9 b	490.2 a	406.9
LSD (0.05);	CT.: 27.88, T.:48.29, T x CT.: 83.64				CT.: 11.45, T.:19.82, T x CT.: 34.34			
LSD (0.05);	Y x CT: 65.00, Y x T: 84.66				Y x CT: 22.10, Y x T: 27.43			

Y: Year, CT: Cutting Time, T: Treatment HV: Hungary Vetch, B: Barley, T: Triticale

**: Averages indicated by the same letters in the same line are different from each other within the error limits of P ≤ 0.01 according to the LSD test.

**: Averages indicated by the same letters in the same column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.

**: Averages of species and mixture x Cutting time interactions indicated by the same letters in the same line and column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.

ratio of legume in mixtures have also been reported by Lithourgidis, Vasilakoglou [12]. They have also stated that the highest quality forage can be obtained by pure sowing vetch and the mixtures containing higher ratio of vetch. The crude protein ratios of species and mixtures were decreased within the vegetation period from the first cutting in booting stage of cereals and 10% flowering stage of vetches to the last cutting in milk dough stage of cereals and pod-setting stage of vetches. Cutting time and accumulation of crude protein in plant tissues are inversely proportional. The excess of photosynthetic surfaces of plants during the early vegetation period results in increased protein content of due the higher and rapid protein synthesis in plant cells. Raw cellulose production increases with plant maturation, while protein content decreases with decreasing photosynthetic surfaces [27]. The forage yield increases by two folds from germination to milk dough stage, while the crude protein ratio decreases by about half [29] The mixtures of 25% HV + 75% B and 25% HV + 75% T were in the different statistical groups during the booting and milk dough stages, whereas they were placed in the same statistical group in flowering stage with the second cutting time (Table 3). The high protein content of Hungarian vetch and similar protein ratios of triticale and barley made the time x cutting time interaction important. The effect of year on crude protein ratios of species and mixtures was significant which made the year x treatment interaction important (Table 3). Thus, mean crude protein ratios of 50% HV + 50% B and 50% HV + 50% T in the first year of the study were not significantly different. However, the crude protein ratio of 50% HV + 50% T mixture in the second year of study was significantly higher than 50% HV + 50% B mixture.

TABLE 3
Average Crude Protein Ratio of Species and Mixtures Investigated

Treatments	Crude Protein Ratio (%)				Crude Protein Yield (kg da^{-1})			
	Cutting Time			Mean	Cutting Time			Mean
	Booting	Flowering	Milk Dough		Booting	Flowering	Milk Dough	
2013								
Pure Sowing HV	20.8 a**	17.5 c	14.7 e	17.7 a**	45.1	46.9	46.2	46.1 e**
Pure Sowing B	10.6 kl	9.9 lm	7.2 p	9.3 g	34.9	37.3	30.8	34.4 g
Pure Sowing T	11.5 ıj	10.1 lm	8.0 o	9.9 f	49.4	52.8	49.8	50.6 d
%25 HV + %75 B	13.2 f-h	11.9 ı	9.0 n	11.4 e	42.9	45.6	37.7	42.1 f
%50 HV + %50 B	15.7 d	13.7 fg	10.9 jk	13.5 c	48.1	49.8	49.3	49.1 de
%75 HV + %25 B	18.3 b	15.6 d	12.8 h	15.7 b	51.9	54.7	51.9	52.9 cd
%25 HV + %75 T	13.8 f	11.9 ı	9.7 mn	11.8 d	51.5	59.8	57.5	56.2 bc
%50 HV + %50 T	16.2 d	13.8 fg	11.4 I-k	13.8 c	55.1	66.1	57.5	59.6 b
%75 HV + %25 T	18.5 b	15.6 d	13.0 gh	15.7 b	62.2	67.2	62.2	63.9 a
Mean	15.4 a**	13.3 b	10.7 c	13.2 B[1]	49.0	53.4	49.2	50.5 B**
LSD (0,05)	CT: 0.58 T: 0.42, T x CT: 0.73				CT: NS, T:3.67, T x CT: NS			
2014								
Pure Sowing HV	23.1 a*	19.6 b	17.3 e	20.0 a*	44.8 j-l**	56.5 e-ı	59.0 d-h	53.5 de**
Pure Sowing B	11.8 fg	10.0 h	8.6 c	10.1 h	34.7 l	44.2 j-l	39.8 kl	39.5 g
Pure Sowing T	12.9 e	11.2 g	9.7 ı	11.3 g	47.1 ı-k	50.8 h-j	53.1 g-j	50.3 ef
%25 HV + %75 B	14.6 d	12.4 ef	10.8 h	12.6 f	39.6 kl	51.1 h-j	51.9 g-j	47.6 f
%50 HV + %50 B	17.5 c	14.8 d	12.9 gh	15.1 d	45.2 jk	63.5 c-f	65.5 c-e	58.1 cd
%75 HV + %25 B	20.3 b	17.2 c	15.1 e	17.6 b	45.5 jk	65.6 c-e	67.9 b-d	59.6 c
%25 HV + %75 T	15.5 b	13.3 c	11.6 d	13.5 e	50.3 h-j	72.9 bc	75.9 ab	66.4 b
%50 HV + %50 T	18.7 c	15.4 d	13.5 d	15.7 c	54.2 f-j	85.9 a	82.9 a	74.3 a
%75 HV + %25 T	20.6 d	17.5 b	15.4 e	17.8 b	62.2 d-g	84.3 a	83.8 a	76.8 a
Mean	17.2 a**	14.6 b	12.8 c	14.9 A	47.1 b**	63.9 a	64.4 a	58.4 A
LSD (0,05)	CT: 1.08 T: 0.59, T x CT: 1.02				CT:5.41, T:5.30, T x CT:9.2			
Mean								
Pure Sowing HV	21.9 a**	18.6 c	15.9 e	18.8 a*	44.9 jk**	51.8 f-ı	52.6 f-ı	49.8 e**
Pure Sowing B	11.2 k	9.9 l	7.9 n	9.7 h	34.8 m	40.6 kl	35.2 lm	36.9 h
Pure Sowing T	12.2 ıj	10.6 k	8.9 m	10.6 g	48.3 h-j	51.8 f-ı	51.4 f-ı	50.5 eg
%25 HV + %75 B	13.9 h	12.1 ıj	9.9 l	11.9 f	41.3 k	48.3 hj	44.8 jk	44.8 g
%50 HV + %50 B	16.6 de	14.3 fgh	11.9 j	14.3 d	46.7 ı-k	56.6 d-g	57.4 d-f	53.6 de
%75 HV + %25 B	19.3 b	16.4 e	13.9 gh	16.6 b	48.7 h-j	60.1 de	59.9 de	56.2 d
%25 HV + %75 T	14.7 f	12.6 ı	10.7 k	12.6 e	50.9 g-j	66.3 bc	66.7 bc	61.3 c
%50 HV + %50 T	17.1 d	14.6 fg	12.4 ıj	14.7 c	54.6 e-h	76.0 a	70.2 ab	66.9 b
%75 HV + %25 T	19.6 b	16.6 de	14.2 f-h	16.8 b	62.2 cd	75.8 a	73.0 a	70.3 a
Mean	16.3 a**	13.9 b	11.8 c	14.0	48.1 b**	58.6 a	56.8 a	54.5
LSD (0,05)	CT: 0.24 T.: 0.42, T x CT: 0.73				CT:1.92, T: 3.32, T x CT:5.8			

LSD (0.05); Y x CT: NS Y x T: 0.51 Y x CT: 4.17, Y x T: 4.52
Y: Year, CT: Cutting Time, T: Treatment HV: Hungary Vetch, B: Barley, T: Triticale
**: Averages indicated by the same letters in the same line are different from each other within the error limits of P ≤ 0.01 according to the LSD test.
**: Averages indicated by the same letters in the same column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.
*: Averages of species and mixture x Cutting time interactions indicated by the same letters in the same line and column are not different from each other within the error limits of P ≤ 0.05 according to the Duncan test.
**: Averages of species and mixture x Cutting time interactions indicated by the same letters in the same line and column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.
**: Averages indicated by the different letters are different from each other within the error limits of P ≤ 0.01.

Crude Protein Yield. The results of two-year averages showed that crude protein yield was significantly different between species and mixtures. The highest crude protein yield (70.3 kg da^{-1}) was obtained from the mixture of 75% HV + 25% T and the lowest (36.9 kg da^{-1}) was from pure sowing barley (Table 3). Legumes are considered as a good source of protein and very important to increase the protein ratio of the mixtures [9, 30]. Vetch, a legume forage crop, has higher crude protein ratio and lower hay yield than cereals. However, the crude protein yield of the mixtures has increased with increasing the ratio of vetch in mixtures due to the direct relationship of crude protein yield with crude protein ratio and hay yield. Similarly, Lithourgidis and Dordas [31] also showed that the greatest advantages of cereal + legume mixture is increasing the yield of crude protein compared to pure sowing cereals.

The increasing crude protein yield and decreasing the crude protein ratio of species and mixtures by the delaying of the cutting time caused to differences in crude protein yield between cutting times. Delaying the vegetation period from booting to milk dough stage led to higher dry matter thus to higher crude protein yield [27]. Many researchers suggested that during maturation progress dry matter yield increases but crude protein content decreases, leading to decrease forage quality [10, 27, 32]. The interaction of treatment x cutting time was significant (p<0.01) due to the differences in the effects of cutting time on crude protein ratio of species and mixtures. Delaying the cutting of pure sowing Hungary vetch from 10% flowering to full flowering increased the crude protein yield. The crude protein yield in the cutting of flowering stage was increased by delaying the harvest of 50% HV + 50% T and 75% HV + 25% T mixtures from booting to flowering.

The crude protein yields of 25% HV + 75% T and 50% HV + 50% T mixtures in the first year of study were not significantly different. However, the crude protein yield of 50% HV + 50% T mixture in the second year was significantly higher than the all species and mixtures except 25% HV + 75% T and 75% HV + 25% T mixtures. The differences in the effects of years on mixtures caused to the year x treatment interaction to be important (p<0.01).

Significant effect of cutting time on crude protein yield depending on years made the year x cutting times interaction important (p <0.01). Delaying the harvests of 50% HV + 50% T and 75% HV + 25% T mixtures from booting to flowering increased the crude protein yield compared to that the cutting in flowering stage. The crude protein yield was significantly increased by the delaying of harvest from flowering to milk dough stage. This as the vegetation progresses may be attributed to the decrease in crude protein ratio and increase in yield of species and mixtures.

The crude protein yield was significantly increased by delaying the harvest from flowering to milk dough stage compared to full flowering stage. This may be due to a decrease in the crude protein ratio of species and mixtures, despite the yield increase as the vegetation progresses.

ADF Ratio. The two-year averages of ADF ratio for species and mixture showed that the lowest ADF ratio was obtained with pure sowing Hungary vetch (28.9%) while the highest was with pure sowing barley (35.3%) (Table 4). Low leaf/stem ratio of cereals and rapid ripening cause the differences in ADF contents of legumes and cereals [33, 34]. Legumes have more cellular compounds and fewer cell wall components due to the differences in ADF contents between legumes and cereals. Consequently, lignification is less frequent in cells [33, 35]. The lowest ADF ratio (29.5%) was obtained in booting stage while the highest (34.9%) was in milk dough stage. The crude protein ratio decreased as the ADF ratio of species and mixtures increased by delaying the harvest from booting to flowering and milk dough stages. Tan and Menteşe [33] stated that delaying the cutting decreased the protein content and increased the amount of elements such as fiber forming the cell wall which is difficult to digest. Turk and Albayrak [32] also reported that cutting time and forage quality were closely related and forage quality decreased with the delay of cutting time.

NDF Ratio. The highest NDF ratio of species and mixtures, according to two-year averages, was obtained with pure sowing barley (55.0%), while the lowest NDF ratio was with pure sowing Hungarian vetch (49.5%) (Table 4). The results indicated that the NDF ratios of barley and triticale were higher than that of Hungarian vetch. The differences in NDF, a factor affecting the digestion, between cereals and legumes are due to the anatomical structure and chemical compositions. Legumes compared to cereals contain more soluble fiber and fewer cell walls thus have more cellular compounds [36]. The low NDF content accelerates the fermentation of herb, reduces the time spent on rumen and increases the consumption. The cutting times significantly affected the NDF ratios and the NDF ratios significantly increased with delaying the cutting time (Table 4). The NDF ratios of species and mixtures increased as vegetation continues from booting (49.7%) to flowering (52.1%) and to milk dough (55.1%) stages. There is a positive relationship between the increase in NDF ratio and the continuation of vegetation period. The NDF content affects the fermentation rate of hay, retention time in rumen and consumability [37]. Therefore, the amount of lignin in forage increases with the delay of cutting time, and lignin forms a bridge between cellulose and hemicellulose, reducing digestion and consumption of forages [38]

The NDF content of species and mixtures differed considerably depending on the cutting times thus the treatment x cutting times interaction is considered important. The NDF values of pure sowing triticale and 25% HV + 75% T mixtures harvested in booting stage was not significantly different. However, differences in the NDF values between the flowering and milk dough stages were statistically significant.

Digestible Dry Matter Ratio (DDMR). The highest DDMR of species and mixtures, according to two-year averages, was obtained with pure sowing Hungarian vetch (66.4%), while the lowest DDMR was with pure sowing barley (61.4%) (Table 5). There is a negative correlation between the ADF ratio which is an indicative of cellulose and lignin content, and DDMR that is calculated from the ADF ratio. In contrast to the lowest ADF ratio with pure sowing Hungarian vetch and the highest ADF ratio with pure sowing barley, the opposite situation was occurred in DDMR. The highest DDMR was obtained with pure sowing Hungarian vetch. The high content of ADF in cereals caused the lower DDMR of legumes [39]. The cutting time is one of the most important factors determining the forage quality. Because, with the prolongation of vegetation period, the increased ADF ratios due to structural changes in plant tissues cause the DDMR values to decrease [27]. Therefore, the highest DDM ratio (69.5%) was

TABLE 4
Average ADF and NDF Ratios of Species and Mixtures Investigated

	ADF (%)				NDF (%)			
	Cutting Time			Mean	Cutting Time			Mean
Treatments	Booting	Flowering	Milk Dough		Booting	Flowering	Milk Dough	
2013								
Pure Sowing HV	27.5	29.9	32.7	30.1 h**	48.6	49.7	52.6	50.3 f**
Pure Sowing B	34.3	35.6	38.2	36.0 a	53.3	55.3	58.3	55.6 a
Pure Sowing T	32.3	35.1	37.7	35.0 b	51.6	55.2	57.4	54.7 b
%25 HV + %75 B	32.6	34.2	36.8	34.5 c	52.1	53.9	56.9	54.3 b
%50 HV + %50 B	30.9	32.8	35.4	33.0 e	50.9	52.5	55.4	52.9 d
%75 HV + %25 B	29.2	31.4	34.1	31.6 g	49.8	51.1	54.0	51.6 e
%25 HV + %75 T	31.1	33.8	36.4	33.8 d	50.8	53.8	56.2	53.6 c
%50 HV + %50 T	29.9	32.5	35.2	32.5 f	50.1	52.5	54.9	52.5 d
%75 HV + %25 T	28.7	31.2	33.9	31.3 g	49.3	51.1	53.8	51.4 e
Mean	30.8 c**	32.9 b	35.6 a	33.1 A**	50.7 c**	52.8 b	55.5 a	53.0 A**
LSD (0,05)	CT: 0.69 T.: 0.46, T x CT: NS				CT.:1.56, T.:0.58, T x CT: NS			
2014								
Pure Sowing HV	24.5	27.1	31.5	27.7 e**	46.3	48.3	51.4	48.7 f**
Pure Sowing B	31.5	34.7	37.6	34.6 a	51.6	53.9	57.6	54.4 a
Pure Sowing T	31.1	33.3	36.5	33.6 b	49.8	53.6	56.8	53.4 b
%25 HV + %75 B	29.7	32.8	36.1	32.9 b	50.3	52.6	56.0	52.9 b
%50 HV + %50 B	27.9	30.9	34.6	31.2 c	48.9	51.1	54.5	51.5 d
%75 HV + %25 B	26.2	29.0	33.0	29.4 d	47.6	49.7	52.9	50.1 e
%25 HV + %75 T	29.4	31.8	33.3	31.5 c	48.9	52.3	55.5	52.2 c
%50 HV + %50 T	27.8	30.2	33.9	30.7 c	48.0	50.9	54.1	51.0 d
%75 HV + %25 T	26.1	28.7	32.8	29.2 d	47.2	49.6	52.8	49.9 e
Mean	28.3 c**	30.9 b	34.4 a	31.2 B	48.7 c**	51.3 b	54.6 a	51.6 B
LSD (0,05)	CT: 1.22 T: 0.88, T x CT: NS				CT:1.59, T:0.63, T x CT: NS			
Mean								
Pure Sowing HV	25.9	28.6	32.1	28.9 h**	47.4 m**	49.0 kl	52.0 g	49.5 h**
Pure Sowing B	32.9	35.1	37.9	35.3 a	52.6 fg	54.6 d	57.9 a	55.0 a
Pure Sowing T	31.7	34.2	37.1	34.3 b	50.7 ıj	54.4 d	57.1 b	54.1 b
%25 HV + %75 B	31.2	33.5	36.4	33.7 c	51.2 hı	53.2 ef	56.5 bc	53.6 c
%50 HV + %50 B	29.5	31.8	34.9	32.1 e	49.9 j	51.8 gh	54.9 d	52.2 e
%75 HV + %25 B	27.7	30.2	33.5	30.5 g	48.7 kl	50.4 j	53.5 e	50.9 g
%25 HV + %75 T	30.3	32.8	34.9	32.6 d	49.9 j	53.1 ef	55.8 c	52.9 d
%50 HV + %50 T	28.9	31.4	34.6	31.6 f	49.1 k	51.7 gh	54.6 d	51.8 f
%75 HV + %25 T	27.4	29.9	33.3	30.2 g	48.3 l	50.4 j	53.3 e	50.6 g
Mean	29.5 c**	31.9 b	34.9 a	32.1	49.7 c**	52.1 b	55.1 a	52.3
LSD (0,05)	CT: 0.31 T: 0.55, T x CT: NS				CT: 0.34, T:0.59, T X CT: 1.03			
LSD (0.05	Y x CT: NS, Y x T: NS				Y x CT: NS, Y x T: NS			

Y: Year, CT: Cutting Time, T: Treatment HV: Hungary Vetch, B: Barley, T: Triticale
**: Averages indicated by the same letters in the same line are different from each other within the error limits of P ≤ 0.01 according to the LSD test.
**: Averages indicated by the same letters in the same column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.
**: Averages of species and mixture x Cutting time interactions indicated by the same letters in the same line and column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.
**: Averages indicated by the different letters are different from each other within the error limits of P ≤ 0.01.

observed in the booting stage of the species and mixtures and the lowest DDM rate (61.7%) in the milk dough stage. The delay of cutting time increases the cell wall components such as cellulose and lignin in the plant that decreases the digestibility of the plant [40]. The leaf/stem ratio and digestibility are decreased with the maturation of cereals [41].

Digestible Dry Matter Yield. The results of two-year study revealed that digestible dry matter yield (DDMY) of species and mixtures significantly was significantly different (Table 5). The highest DDMY was obtained with 25% HV + 75% T mixture while the lowest DDMY was from pure sowing Hungary vetch.

The dry matter yield of cereals is higher than that of legumes due to the stronger development and excess dry matter ratios [25]. The dry matter yield, according to two-year averages, was significantly affected by the cutting times. Similar to DDM ratio, extending the vegetation period from booting to milk dough stage increased the DDMY. Increasing dry matter production in plants with the extent of vegetation period also resulted in increased dry hay yield [25]. However, the ADF and NDF ratios also rapidly increased along with maturation in plant.

The interaction of treatment x cutting time was significant (p<0.01) due to the differences in the effects of cutting time on digestible dry matter yield of species and mixtures. Delaying the harvest of 50% HV + 50% T from booting to flowering significantly increased the digestible dry matter yield. The digestible dry matter yield was increased by delaying of harvest to milk dough stage. Significant differences in the effects of years on digestible dry matter yields of species and mixtures made the year x treatment interaction significant (p<0.01).

Pure sowing vetch yielding high digestible dry matter yield in the first year due to the high dry matter yield was not included among the high digestible dry matter yielding treatments in the second year. The mixtures of 25% HV + 75% T and 50% HV + 50% T were not included in high digestible dry matter yielding group in the first year. These mixtures in the second year, however, constituted the statistical group in which the high digestible dry matter yield is obtained.

Significant differences in the effects of years on digestible dry matter yield made the year x cutting time interaction significant (Table 5). Therefore, the digestible dry matter yield obtained in the booting stage of first year was significantly higher than that of the second year.

TABLE 5
Digestible Dry Matter Ratio and Digestible Dry Matter Yield of Species and Mixtures Investigated in the Study.

Treatments	Digestible Dry Matter Ratio (%)				Digestible Dry Matter Yield (kg da^{-1})			
	Cutting Time			Mean	Cutting Time			Mean
	Booting	Flowering	Milk Dough		Booting	Flowering	Milk Dough	
2013								
Pure Sowing HV	67.5	65.6	63.5	65.5 a**	146.7 i*	176.0 h	199.9 gh	174.2 e**
Pure Sowing B	62.2	61.2	59.1	60.8 h	204.7 gh	229.0 e-g	253.9 de	229.2 d
Pure Sowing T	63.7	61.6	59.5	61.6 g	273.9 cd	322.1 b	370.0 a	322.0 a
%25 HV + %75 B	63.5	62.3	60.2	62.0 f	207.4 f-h	239.9 ef	251.0 de	232.8 d
%50 HV + %50 B	64.8	63.4	61.3	63.2 d	198.1 gh	229.9 e-g	277.5 cd	235.2 d
%75 HV + %25 B	66.1	64.5	62.4	64.3 b	188.2 h	226.0 e-g	253.9 de	222.7 d
%25 HV + %75 T	64.7	62.6	60.5	62.6 e	240.2 ef	314.3 b	359.1 a	304.5 b
%50 HV + %50 T	65.6	63.6	61.5	63.6 c	224.3 e-g	305.6 bc	311.7 b	280.5 c
%75 HV + %25 T	66.5	64.6	62.5	64.5 b	224.2 e-g	277.6 cd	298.3 bc	266.7 c
Mean	64.9 a**	63.3 b	61.2 c	63.1 B**	212.0 c**	257.8 b	286.1 a	252.0 B**
LSD (0.05)	CT: 0.54, T: 0.36, T x CT: NS				CT: 14.31, T: 0.16.71, T x CT: 28.94			
2014								
Pure Sowing HV	69.9	67.8	64.4	67.3 a**	135.2 p**	195.5 mn	221.1 km	183.9 e**
Pure Sowing B	64.4	61.9	59.6	62.0 e	188.7 mn	273.3 hı	276.3 hı	246.1 cd
Pure Sowing T	64.7	63.0	60.5	62.7 d	235.0 j-l	285.9 g-ı	330.5 c-e	283.8 b
%25 HV + %75 B	65.7	63.3	60.8	63.3 d	178.3 no	260.5 h-j	294.0 f-h	244.2 cd
%50 HV + %50 B	67.1	64.8	62	64.6 c	174.1 no	277.2 hı	313.5 e-g	254.9 c
%75 HV + %25 B	68.5	66.3	63.2	66.0 b	152.7 op	251.8 ı-k	283.3 g-ı	229.3 d
%25 HV + %75 T	66.0	64.2	62.9	64.4 c	220.4 k-m	351.5 b-d	409.9 a	327.3 a
%50 HV + %50 T	67.3	65.4	62.4	65.0 c	201.6 l-n	364.3 bc	383.0 ab	316.3 a
%75 HV + %25 T	68.6	66.6	63.4	66.2 b	206.7 l-n	320.4 d-f	345.6 c-e	290.9 b
Mean	66.9 a**	64.8 b	62.1 c	64.6 A	188.1 c**	286.7 b	317.5 a	264.1 A
LSD (0.05)	CT: 0.95 T: 0.69, T x CT: NS				CT:16.83, T:18.16, T x CT:31.46			
Mean								
Pure Sowing HV	68.7	66.7	63.9	66.4 a**	141.0 m**	185.8 kl	210.5 ıj	179.1 f**
Pure Sowing B	63.3	61.5	59.4	61.4 h	196.7 jk	251.2 f-h	265.1 f	237.6 de
Pure Sowing T	64.2	62.3	60.0	62.2 g	254.4 fg	304.0 de	350.3 b	302.9 b
%25 HV + %75 B	64.6	62.8	60.5	62.6 f	192.9 jkl	250.2 f-h	272.5 f	238.5 de
%50 HV + %50 B	66.0	64.1	61.6	63.9 d	186.1 kl	253.6 f-h	295.5 e	245.1 d
%75 HV + %25 B	67.3	65.4	62.8	65.2 b	170.4 l	238.9 gh	268.6 f	226.0 e
%25 HV + %75 T	65.3	63.4	61.7	63.5 e	230.3 hı	332.9 bc	384.5 a	315.9 a
%50 HV + %50 T	66.4	64.5	62.0	64.3 c	212.9 ıj	334.9 bc	347.3 b	298.4 b
%75 HV + %25 T	67.5	65.6	62.9	65.4 b	215.4 ıj	299.0 e	322.0 cd	278.8 c
Mean	65.9 a**	64.0 b	61.7 c	63.9	200.0 c**	272.3 b	301.8 a	258.0
LSD (0.05)	CT: 0.49 T: 0.38, T x CT: NS				CT.:9.83, T:12.24, T x CT: 21.19			
LSD (0.05	Y x CT: NS, Y x CT: NS				Y x CT: 13.91, Y x T: 17.30			

Y: Year, CT: Cutting Time, T: Treatment HV: Hungary Vetch, B: Barley, T: Triticale

**: Averages indicated by the same letters in the same line are different from each other within the error limits of P ≤ 0.01 according to the LSD test.

**: Averages indicated by the same letters in the same column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.

*: Averages of species and mixture x Cutting time interactions indicated by the same letters in the same line and column are not different from each other within the error limits of P ≤ 0.05 according to the Duncan test.

**: Averages of species and mixture x Cutting time interactions indicated by the same letters in the same line and column are not different from each other within the error limits of P ≤ 0.01 according to the Duncan test.

**: Averages indicated by the different letters are different from each other within the error limits of P ≤ 0.01.

CONCLUSION

The mixture of legumes + cereals grown in winter is of great importance in meeting the forage demand in the ecologies similar to arid conditions where the precipitation is limited. Attention should be given to the optimum mixing ratio and cutting time of cereal + legume mixtures that rapidly grow due to sudden increase of temperature and spring precipitation. The results revealed that delaying the harvest from booting to milk dough stage increased the hay yield while forage quality has been negatively affected. Mixtures, yield and quality were evaluated together were found superior than pure sowing of species. The increasing the legume ratio in mixtures increased the quality of forage while the yield was negatively affected. Increasing the legume + cereal cultivation in arid conditions province may be a solution to the forage problem of this region. High yield and quality forage in the region can be obtained with the mixture of 50% HV + 50% T and cutting in the flowering stage of triticale.

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REFERENCES

REFERENCES

[1] Erdurmus, C., Cakmakci, S. (2018) Morphological Characterization of Button Medic (*Medicago Orbicularis* L.) Collected From Natural Flora Of Antalya Province. Fresen. Environ. Bull. 27, 1593-603.

[2] Aksoy, I., Nursoy, H. (2010) Determination of the Varying of Vegetation Harvested Hungarian Vetch and Wheat Mixture on Nutrient Content, Degradation Kinetics, Invitro Digestibility and Relative Feed Value. Journal of the Faculty of Veterinary Medicine, Kafkas University. 16(6), 925-31.

[3] Hayden, Z., Ngouajio, M., Brainard, D. (2014) Rye–vetch Mixture Proportion Tradeoffs: Cover Crop Productivity, Nitrogen Accumulation, and Weed Suppression. Agronomy Journal. 106(3), 904-14.

[4] Kavut, Y. (2016) A Research on Grass Field Yield and Some Other Features of Mixture of Italian Ryegrass Forage Harvested of Different Periods and Some Legumes Crops. Journal of Field Crops Central Research Institute. 25(Special issue-2), 253-8.

[5] Eğritaş, Ö., Aşcı, Ö. (2015) Determination of Some Mineral Matter Contents in Common Vetch-Cereals Mixtures. Academic Journal of Agriculture. 4(1), 13-8.

[6] Lithourgidis, A., Dordas, C., Damalas, C., Vlachostergios, D. (2011) Annual Intercrops: An Alternative Pathway for Sustainable Agriculture. Aust J Crop Sci. 5(4), 396-410.

[7] Arpali, D., Gulser, F., Yagmur, M. (2016) The Effects of Sewage Sludge Application on Grain Yield and Nutrient Status of Grain in Triticale Under Rainfed Conditions. Fresenius Environ Bull. 25, 4848-55.

[8] Göçmen, N., Parlak, A.Ö. (2017) Determination of Seeding Raties of Pea Intercrops With Oat, Barley and Triticale. COMU Journal of Agriculture Faculty. 5(1), 119-24.

[9] Eskandari, H., Ghanbari, A., Javabnard, A. (2009) Intercropping of Cereals and Legumes for Forage Production. Notulae Scientia Biologicae. 1(1), 07.

[10] Yavuz, T. (2017) The Effects of Different Cutting Stages on Forage Yield and Quality in Pea (*Pisum sativum* L.) and Oat (*Avena sativa* L.) Mixtures. Journal of Field Crops Central Research Institute. 26(1), 67-74.

[11] Işık, Ş., Ateş, S., Keleş, G., İnal, F., Güneş, A., (eds.) (2014) The Production and Nutritive Value Of Triticale, Hungarian Vetch And The Mixture Of Two During Their Different Growth Stages. 10.Field Crops Congress. Konya.

[12] Lithourgidis, A., Vasilakoglou, I., Dhima, K., Dordas, C., Yiakoulaki, M. (2006) Forage Yield and Quality of Common Vetch Mixtures With Oat and Triticale in Two Seeding Ratios. Field Crop Res. 99(2-3), 106-13.

[13] Dordas, C., Vlachostergios, D., Lithourgidis, A. (2012) Growth Dynamics and Agronomic-Economic Benefits of Pea-Oat and Pea-Barley Intercrops. Crop and Pasture Science. 63(1), 45-52.

[14] Sayar, M.S., Anlarsal, A.E., Başbağ, M. (2016) Additive Main Effects and Multiplicative Interactions (AMMI) Analysis for Biological Yield in Hungarian Vetch (*Vicia pannonica* Crantz) Genotypes. Journal of Field Crops Central Research Institute. 25(Special issue-2), 235-40.

[15] Mut, Z., Ayan, I., Mut, H. (2006) Evaluation of Forage Yield and Quality at Two Phenological Stages Of Triticale Genotypes And Other Cereals Grown Under Rainfed Conditions. Bangladesh Journal of Botany 35(1), 45-53.

[16] Sleugh, B., Moore, K.J., George, J.R., Brummer, E.C. (2000) Binary Legume-Grass Mixtures Improve Forage Yield, Quality, And Seasonal Distribution. Agronomy Journal. 92(1), 24-9.

[17] AOAC. (2005) Official Methods of Analysis. Association of Official Analytical Chemists. 18th ed. Horwitz, W., George, W. Latimer, (eds.) Association of Official Analytical Chemists International, Maryland, USA.

[18] Anonymous. (2017) Analytical Methods Fiber Analyzer A200 2017 [18.12.2017]. Available from: www.ankom.com/analytical-methods-support/fiber-analyzer-a200.

[19] Sheaffer, C., Peterson, M., McCaslin, M., Volenec, J., Cherney, J., Johnson, K., W.T. Woodward, W and Viands, D. (1995) Acid Detergent Fiber, Neutral Detergent Fiber Concentration and Relative Feed Value. Standart Tests to Characterize Alfalfa Cultivars Available online at: http://www.naaic.org/std tests/acid-fiber.htm (Website accessed: March 15, 2015).

[20] Petersen, R.G. (1994) Agricultural Field Experiments: Design and Analysis: CRC Press.

[21] Dhima, K.V, Lithourgidis, A.S., Vasilakoglou, I.B., Dordas, C.A. (2007) Competition indices of Common Vetch and Cereal Intercrops in Two Seeding Ratio. Field Crop Res. 100(2-3), 249-56.

[22] Varughese, G., Barker, T., Saari, E. (1987) Triticale. International Maize Wheat Improvement Center. CIMMYT.

[23] Çakmakçi, S., Aydınoğlu, B., Arslan, M., Bilgen, M. (2005) Effect of Different Sowing Methods on Forage Yield of Common Vetch (*Vicia sativa L.*) + Perennial Ryegrass (*Lolium perenne* L.) Mixtures. Mediterranean Agricultural Sciences. 18(1), 107-12.

[24] Yılmaz, Ş., Günel, E. (1996) A Reserch to Determınation of The Most Suitable Seeding Rates and Cutting Times of Common Vetch (*Vicia sativa* L.)+ Barley (*Hordeum vulgare* L.) Mixture Under Hatay Ecological Condition Turkey Third Grassland and Forage Crops Congress. 17-19 June, Erzurum. 355-61.

[25] Hatipoğlu, R., Anlarsal, A.E., Tükel, T., Baytekin, H. (1990) Effect of Cutting Stages on Forage Yield and Botanical Composition of Vetch+Barley Mixture in Cukurova Region Arid Conditions. Journal of Cukurova University Agriculture Faculty. 5(3), 173-82.

[26] Ay, U., Altın, M., Şen, C. (2017) Effect on Yield and Quality of Different Mixtures Ratios and Harvesting Periods of Fodder Pea (*Pisum arvense* L.) and Wheat (*Triticum aestivum* L.) in Kırklareli Conditions. Journal of Tekirdag Agricultural Faculty. 14(3), Epub 85.

[27] Geren, H., Soya, H., Avcıoğlu, R. (2003) Investigations on The Effect of Cutting Dates on Some Quality Properties of Annual Italian Ryegrass and Hairy Vetch Mixtures. Journal of Agriculture Faculty of Ege University. 40(2).

[28] Acar, Z., Gulumser, E., Asci, O.O., Basaran, U., Mut, H., Ayan, I. (2017) Effects of Sowing Ratio and Harvest Periods On Hay Yields, Quality and Competitive Characteristics Of Hungarian Vetch-Cereal Mixtures. Legume Res. 40(4), 677-83.

[29] Johnston, J., Wheeler, B., McKinlay, J. (1998) Forage Production From Spring Cereals and Cereal-Pea Mixtures. Ministry of Agriculture, Food and Rural Affairs.

[30] Aydinoglu, B. (2018) Ersity in Seed Yield and Yield Components of Narbon Vetch (*Vicia Narbonensis* L.) Genotypes. Fresenius Environ Bull. 27(4), 2523-9.

[31] Lithourgidis, A., Dordas, C. (2010) Forage Yield, Growth Rate, and Nitrogen Uptake of Faba Bean Intercrops with Wheat, Barley, and Rye in Three Seeding Ratios. Crop Sci. 50(5), 2148-58.

[32] Turk, M., Albayrak, S. (2012) Effect of Harvesting Stages on Forage Yield and Quality of Different Leaf Types Pea Cultivar. Turk J Field Crops. 17(2), 111-4.

[33] Tan, M., Menteşe, Ö. (2003) Effects of Anatomic Structure and Chemical Composition on Forage Quality. Journal of the Faculty of Agriculture. 34(1), Epub 103.

[34] Özyiğit, Y., Bilgen, M. (2006) Effect of Different Cutting Stages on Some Quality Factors in Various Legume Forage Crops. Mediterranean Agricultural Sciences. 19(1), 29-34.

[35] Griffith, C. (2017) Potential to Improve Fiber Digestion in the Rumen: University of Alberta.

[36] Cherney, D., Cherney, J., Davidson, A. (1997) Characterization of Legume and Grass Residues Following in Vitro and in Sacco Ruminal Digestion. Proc. The XVIII. International Grassland Cong., June, 8-17.

[37] Özkul, H., Kırkpınar, F., Tan, K. (2012) Utilization of Caramba (*Lolium Multiflorum* cv. Caramba) Herbage in Ruminant Nutrition. Journal of Animal Production. 53(1), 21-6.

[38] Yavuz, M. (2005) Deterjan lif sistemi. Gaziosmanpaşa University Faculty of Agriculture Journal. 22(1), 93-96.

[39] Karagić, Đ., Vasiljević, S., Katić, S., Mikić, A., Milić, D., Milošević, B. and Dušanić, N. (2011) Yield and Quality of Winter Common Vetch (*Vicia sativa* L.) Haylage Depending on Sowing Method. Biotechnology in Animal Husbandry. 27(4), 1585-94.

[40] Van Soest, P.J. (1994) Nutritional Ecology of The Ruminant. Cornell University Press.

[41] Taş, N. (2011) The Effect of Optimum Mixture Type and Rate, and Cutting Time on Hay Yield and Yield Components for Vetch+Wheat Mixtures Sown in Spring and Autumn Under Rainfed Conditions. Anadolu Journal of Aegean Agricultural Research Institute. 21(1), 1-15.

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