IJAFLS
e-ISSN: 2602-4381
International Journal of Agriculture, Forestry and Life Sciences
Original Article | Open access | Int J Agric For Life Sci (2024) 8(2): 34-37

A Study on Herbage Yield and Quality of Different Ratios of Vetch (*Vicia* sp.) and Wheat (*Triticum* sp.) Mixtures

Neziha Binici[1] **Ömer Süha Uslu**[1]*

[1] Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Department of Field Crops
***Correspondence:** suhauslu@ksu.edu.tr

Citation
Binici, N., Uslu, Ö.S. (2024). A Study on Herbage Yield and Quality of Different Ratios of Vetch (Vicia sp.) and Wheat (Triticum sp.) Mixtures. Int J Agric For Life Sci (2024) 8(2): 34-37

Received :23 October 2024
Accepted :7 December 2024
Published Online :27 December 2024
Year: :2024
Volume :8
Issue :2 (December)
Pages :34-37

Available online https://dergipark.org.tr/ijafls

Abstract
The aim of this study was to determine the appropriate mixture ratios by experimenting the mixed sowing of vetch and wheat, which is a valuable forage crop in Kahramanmaras province located in the east of the Mediterranean Region, and to examine the hay yield and quality. The research according to the randomized complete block design (RCBD) with three replications. One mixture form (Wheat + Vetch) and five mixture ratios (100:0, 75:25, 50:50, 25:75, 0:100) were used. According to the results, it was observed that the mixture ratio had statistically significant effects on plant height, green herbage yield, vetch ratio in green and dry herbage, total proportional yield, crude protein ratio and yield, NDF ratio and relative feed value. As the proportion of wheat among the seeds in the mixture increased, the green herbage yield increased in general, while the crude protein ratio decreased. The contribution rates of vetch mixtures to green and dry herbage yield were lower than those of seed mixtures. The results obtained showed that vetch + wheat mixed sowing practices yielded higher amounts of green and dry herbage the plain sowing practices in terms of herbage yield and quality in Kahramanmaras province and in the conditions dominated by the typical Mediterranean climate. It was also observed that common vetch had superior characteristics than hungarian vetch in terms of proportional yield. As a result of the research, it was concluded that 75% wheat + 25% common vetch mixture is the most suitable mixture in terms of both herbage yield and quality and more functional use of ecological resources under the conditions of Kahramanmaras province.

Key words
ADF and NDF ratio, wheat, vetch, mixture ratio, protein ratio, herbage yield and quality.

Introduction
Forage crops like vetch, fodder peas, and damson, among annual legumes, often suffer from lodging due to their creeping and weak stem structure. This makes harvesting challenging, leading to decreased grass quality and yield due to leaf loss and decay (Anlarsal et al., 1996; Tan and Serin, 1996). In our country, many forage plant species can be easily grown, especially annual ones, but their cultivation faces challenges such as farmers' limited knowledge, small-scale farms, and lack of crop rotation planning. Vetch is one of the most cultivated forage crops after alfalfa in Turkey (Anonymous, 2013). However, vetch plants with weak stems face lodging issues and reduced hay and seed yields when grown without support plants (Açıkgöz, 2001). Mixing vetch with grasses addresses this problem by reducing rotting, lodging, and leaf loss due to grasses' upright growth habit, easing harvesting (Bakoğlu and Memiş, 2002). This mixed planting is recommended to enhance hay yield, given that grasses have lower crude protein but higher crude cellulose content compared to vetch (Avcıoğlu and Avcıoğlu, 1982; Korkmaz et al., 1993). Mixed cropping, where two or more plant varieties are grown together, requires careful consideration of suitable species and proportions to create a competitive yet beneficial environment (Pekşen and Gülümser, 1995; Arslan, 2012). Adjusting planting rates is crucial for maximizing the benefits of mixed planting (Serin et al., 1999). Research has shown varied outcomes: in Bursa, a 50% common vetch + 50% oat mixture resulted in the highest protein yield, while in Tokat 33% barley + 67% Hungarian vetch mixture produced the highest crude protein yield and dry matter (Bayram and Çelik, 1999; İptaş and Yılmaz, 1998). The aim of this study was to investigate the effects of mixed sowing of vetch and wheat, which is a valuable forage crop, at different rates on morphological development, herbage yield and quality in Kahramanmaraş province located in the east of the Mediterranean Region.

Materials and Methods
Material
This study was conducted in the experimental field of Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Field Crops during the 2017-2018 winter cropping season. The experimental field is located in the Mediterranean region between 37°35'40.86" north latitude and 36°48'47.51" east longitude and has a slope of 3-5%. It is 487 m above sea level. Two vetch and one wheat species were used as plant material. Ayaz-08 (common vetch) (*Vicia sativa* L.) and Tarım Beyazı-98 (Hungarian vetch) (*Vicia pannonica* Crantz.) varieties were preferred as vetch species and Ceyhan-99 (*Triticum aestivum* L.) variety was preferred as wheat species. As a result of the analysis of the soil sample taken from 0-30 cm depth, it was determined as heavy textured (85.8% clayey), neutral (pH 7.28), slightly saline (0.30%), very slightly calcareous (1%), medium in terms of organic matter (2.08%), high in potassium (266.8 mg/kg) and low in phosphorus (10.46 mg/kg) (Anonymous, 2018a). Kahramanmaraş is located in the East-Mediterranean region of Turkey. Under the influence of the Mediterranean climate, the city has hot and dry summers and mild and rainy winters. Total precipitation in Kahramanmaraş during the research season was 523.5 mm, the average temperature was 14.7 °C and the average relative humidity was 59.97%, while the long-term average precipitation in the same period was 650.8 mm, the average temperature was 12.6 °C and the average relative humidity was 63.04% (Anonymous, 2018b).

Method
The research was carried out with 3 replications according to the randomized complete block design on the area which was deep ploughed with a plow for field preparation and then cultivated and tapped. Sowing was done manually in 6 rows of 3 m length with a row spacing of 20 cm. The number of seed calculated for each plot was distributed equally to 6 rows and vetch and wheat were sown in the same row as a mixture. The plot size was 1.2 m x 3 m = 3.6 m^2. Hungarian vetch was sown at 12 kg/ha, wheat at 25 kg/ha (Çaçan and Yılmaz, 2015) and common vetch at 200 seeds/m^2 (Yücel et al., 2012). After sowing, fertilization was applied with 20.20.0 compound base fertilizer containing 5 kg/da pure N and P, taking into account the soil analysis results. One mixture form (Vetch + Wheat) and five mixture ratios (100:0, 75:25, 50:50, 25:75, 0:100) were considered in the study. Harvesting was done after one row from the sides of the plot and 50 cm from the top and bottom of the plot. The harvested plot area was 1.6 m^2. Sowing was done on November 27, 2017, and harvesting was done on April 27, 2018, when the lower pods appeared in vetch and wheat reached the milk maturity stage. The experiment was not irrigated. Weed control was done manually. The characteristics examined were analysed according to the methods described by De Wit and Van den Bergh (1965), Kaçar (1972), Anlarsal (1987), Yağbasanlar (1987), Şılbır et al. (1991), Van Soest et al. (1991), Sheaffer et al. (1995), Van Dyke and Anderson (2002) and Kutlu (2008). The natural plant height of vetch was measured by measuring the height of 10 randomly selected vetch plants in the field and the height at which they were wrapped with wheat. In 10 wheat plants, wheat plant height was measured by measuring the distance between the soil surface and the last spikelet in cm. In addition, vetch stem length was determined by measuring the distance between the soil surface and the last bud in cm in 10 randomly selected common vetch and hungarian vetch plants in each plot. These measurements were then averaged. After subtracting the edge effect, the grass obtained in the form was weighed and the plot wet weight was found. The values were converted into kg/ha units and green herbage yield was calculated. From each plot, 500 g of vetch and 500 g of wheat herbage samples were dried in an oven at 70°C for 48 hours. Then, the dry herbage samples were weighed and their weights were determined. Based on this, vetch and wheat dry herbage yields of the plots were calculated. Vetch and wheat dry herbage yields determined for each plot were summed and total dry herbage yield was found separately for each plot. This value was converted into decare herbage yield. The herbage harvested from each plot was separated

into its components as vetch and wheat, their green and dry weights were determined, these weights were proportioned to the total green and dry herbage yield of the plot, and the ratio of vetch in green and dry herbage was determined. Dried plant samples were ground and sieved through a 1 mm sieve and prepared for analysis. The ground hay samples were analysed for nitrogen determination by Kjeldahl method. The measured nitrogen percentage values were then multiplied by a coefficient of 6.25 and the crude protein content of each sample was determined. Using the crude protein content value calculated in each plot, the following equation was used and the crude protein content of the plot hay was found.

The crude protein rate of the plot was multiplied by the dry herbage yield of the plot and the crude protein yield was determined, then the necessary conversions were made and the crude protein yield was calculated in kg/decare. In the determination of crude ash content, 3-gram samples obtained from plant samples dried at 105 ℃ and cooled in a desiccator were placed in a porcelain crucible and burned at 550 ℃ for 3 hours. Crude ash content was calculated by proportioning the ash obtained to the burned sample.

The total proportional yield is considered as a measure of the efficiency with which ecological resources are utilized when crops sown in mixtures are sown alone. It was calculated with the following formula using the dry herbage yields in the mixtures.

RYT = VHY(M) / VHY(P) + WHY(M) / WHY(P)

RYT = Relative Yield Total

VHY(M) = Vetch dry herbage yield (in mixture)

VHY(P) = Vetch dry herbage yield (pure sowing)

WHY(M) = Wheat dry herbage yield (in mixture)

WHY(P) = Wheat dry herbage yield (pure sowing)

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were determined by ANKOM A220 fiber analyser (ANKOM Technology, Fairport, NY) using ANKOM filter bag technique.

Digestible dry matter (DDM) value, dry matter intake (DMI) value and relative feed value (RFV) were calculated by using the following formulas by evaluating NDF and ADF analysis results.

DDM% = 88.9 - (0.779 x ADF%)

DMI% = 120 / NDF%

RFV = (DDM x DMI) / 1.29

The data obtained as a result of the research were subjected to analysis of variance in SAS (Anonymous, 2014) statistical package program based on the randomized complete block design. According to the results of analysis of variance, the differences between the mean values of the statistically significant traits were compared using LSD test.

Results and Discussion

The averages of the characteristics examined in the study are given in Tables 1, 2 and 3. As seen in Table 1, the effect of mixture ratios on vetch natural plant height, wheat natural plant height, vetch stem length and green herbage yield were found statistically significant.

Table 1. The averages of vetch natural plant height (VNPH), wheat natural plant height (WNPH), vetch stem length (VSL) and green herbage yield (GHY) determined in vetch + wheat mixtures and the groups

Mixtures	VNPH (cm)	WNPH (cm)	VSL (cm)	GHY (kg/da)
Pure Wheat	-	81.61 a	-	2159.6 ab
Pure Common Vetch	39.20 c	-	72.57 b	2232.3 ab
Pure Hungarian Vetch	40.13 c	-	63.57 b	1861.1 b
25% Wheat + 75% Common Vetch	62.20 b	76.17 b	72.73 b	2124.0 ab
50% Wheat + 50% Common Vetch	72.20 a	78.62 b	77.70 b	2126.7 ab
75% Wheat + 25% Common Vetch	63.13 b	83.32 a	94.87 a	2706.0 a
25% Wheat + 75% Hungarian Vetch	68.67 b	79.20 b	70.97 b	2186.5 ab
50% Wheat + 50% Hungarian Vetch	64.50 b	81.27 a	69.23 b	2164.6 ab
75% Wheat + 25% Hungarian Vetch	63.67 b	79.40 b	68.25 b	2067.9 ab
Mean	61.70	70.99	65.54	2180.9
F Value	14.69**	55.73**	25.38**	0.97*
LSD	15.54	7.17	10.85	679.64
CV (%)	10.16	5.84	13.70	18.00

*Significant according to p<0.05, **Significant according to p<0.01, LSD: Minimum significant difference, CV: Coefficient of variation

Table 1 shows that the highest natural plant height of vetch was obtained in 50% Wheat + 50% Common Vetch mixture (72.20 cm) and the lowest natural plant height of vetch was obtained in Pure Common Vetch (39.20 cm). The highest wheat natural plant height was obtained in 75% Wheat + 25% Common Vetch mixture (83.32 cm) and the lowest wheat natural plant height was obtained in 25% Wheat + 75% Common Vetch (76.17 cm). The highest vetch stem length was obtained in 75% Wheat + 25% Common Vetch mixture (94.87 cm) and the lowest vetch stem length was obtained in Pure Hungarian Vetch (63.57 cm). Avcıoğlu et al. (2000) and Yolcu et al. (2009) observed that legume plant height increased in parallel with the increase in legume ratio in the mixture. It can be said that mixed planting increases plant height due to light competition. It was determined that wheat height was longer in mixtures with high grasses ratio. We can say that mixed planting increases plant height due to light competition. When the pure plantings were compared with the other mixtures, it can be said that the higher plant height in the mixtures was due to the competition between vetch and wheat. This situation proves that interspecific competition is effective rather than intraspecific competition (Geren et al., 2007).

The highest green herbage yield was 2706.0 kg/ha in 75% Wheat + 25% Common Vetch mixture and the lowest was 1861.1 kg/ha in Pure Common Vetch planting (Table 1). It was observed that the herbage yield was higher in mixed plantings compared to pure plantings. In previous studies, it was stated that green herbage yields were different from each other depending on genotypes.

As can be seen from Table 2, the effects of different mixture ratios on the averages of vetch rate in green herbage, relative yield total, crude ash rate, crude protein rate and crude protein yield were statistically significant. The highest values of vetch rate in green herbage from pure common vetch and pure hungarian vetch plots were 25 % Wheat + 75 % Common Vetch (29.71 %) and 25 % Wheat + 75 % Hungarian Vetch (27.75 %). The lowest ratio of vetch in green herbage was obtained in 50% Wheat + 50% Hungarian Vetch mixture (13.80%) (Table 2). The highest average relative yield total was obtained in the mixture of 75% Wheat + 25% Common Vetch (1.32) and the lowest average relative yield total was obtained in the mixture of 50% Wheat + 50% Hungarian Vetch (0.84) (Table 2). Relative yield total (RYT), which is an indicator of the efficiency of using ecological resources when grown as a mixture compared to pure cultivation of the species that make up the mixture; When it is less than 1, it means that growing the mixture components separately in the same area has a yield advantage over growing the mixture, when this value is equal to 1, it means that there is no difference in yield between growing the mixture components separately and growing them as a mixture, and when it is greater than 1, it means that growing the mixture has a yield advantage over growing the mixture components separately (De Wit and Van den Bergh, 1965). According to this situation, it can be said that common vetch and wheat mixtures utilize ecological resources more efficiently than pure plantings with hungarian vetch and wheat mixtures.

Table 2. The averages of vetch ratio in green herbage (VRGH), relative yield total (RYT), crude ash ratio (CAR), crude protein ratio (CPR) and crude protein yield (CPY) determined in vetch + wheat mixtures and the groups

Mixtures	VRGH (%)	RYT	CAR (%)	CPR (%)	CPY (kg/da)
Pure Wheat	-	1.00 b	7.88 cd	4.65 d	71.87 d
Pure Common Vetch	100.00 a	1.00 b	10.09 a	20.93 a	151.38 ab
Pure Hungarian Vetch	100.00 a	1.00 b	10.10 a	22.52 a	165.16 a
25% Wheat + 75% Common Vetch	29.71 b	1.11 ab	8.69 bc	8.67 b	109.92 bcd
50% Wheat + 50% Common Vetch	21.57 bc	1.05 ab	10.27 a	7.66 bc	101.78 cd
75% Wheat + 25% Common Vetch	15.84 cd	1.32 a	8.43 c	7.14 bc	128.97 abc
25% Wheat + 75% Hungarian Vetch	27.75 b	1.00 b	7.48 d	8.91 b	109.10 bcd
50% Wheat + 50% Hungarian Vetch	12.98 d	0.84 b	7.54 d	6.12 cd	75.85 d
75% Wheat + 25% Hungarian Vetch	13.80 cd	0.94 b	9.49 ab	5.93 cd	84.80 cd
Mean	35.74	1.02	8.89	10.28	110.98
F Value	173.99**	1.80*	16.75**	82.89**	4.69**
LSD	8.51	0.29	0.82	2.18	44.92
CV (%)	13.76	16.55	5.38	12.28	23.38

*Significant according to p<0.05, **Significant according to p<0.01, LSD: Minimum significant difference, CV: Coefficient of variation

The highest crude ash content was found in 50% Wheat + 50% Common Vetch (10.27%) mixture, followed by Pure Common Vetch (10.10%) and Pure Wheat (10.9%) treatments in the same statistical group. The lowest crude ash content was obtained from the mixture of 25% Wheat + 75% Hungarian vetch (7.48%). Crude ash content is also an indicator of macro and micronutrient content of plants. Mineral substances are vital for plants. It was determined that ash content of legume forage crops was higher than that of grasses forage crops.

The highest crude protein content and yield were obtained from Pure Hungarian Vetch (22.52% and 165.16 kg/ha) and the lowest crude protein content and yield were obtained from Pure Wheat (4.65% and 71.87 kg/ha) (Table 2). This difference is an expected result. It is known that legume forage crops have higher protein ratios than grasses forage crops. As the vetch rate in the mixture decreased, the crude protein rate also decreased. It is understood that there is a positive correlation between vetch ratio and crude protein ratio. One of the main purposes of mixed sowing of legumes with grasses is to increase the quality of the grasses and to ensure that the free nitrogen of the air is used by the grasses by binding it to the soil thanks to the Rhizobium bacteria in the roots of the legumes and to reduce the consumption of chemical fertilizers. In our study, the decrease in the proportion of legumes in the mixture resulted in a decrease in the crude protein ratio.

Table 3. The averages of neutral detergent fiber (NDF), acid detergent fiber (ADF), digestible dry matter (DDM), dry matter intake (DMI) and relative feed value (RFV) determined in vetch + wheat mixtures and the groups

Mixtures	NDF (%)	ADF (%)	DDM %)	DMI (%)	RFV
Pure Wheat	48.20 bc	28.09	67.02	2.54 bc	132.33 ab
Pure Common Vetch	40.25 d	33.66	62.68	2.98 a	145.00 a
Pure Hungarian Vetch	47.00 c	32.37	63.68	2.60 b	128.67 abc
25% Wheat + 75% Common Vetch	53.69 abc	31.59	64.29	2.25 bcd	112.33 bcd
50% Wheat + 50% Common Vetch	54.11 abc	31.76	64.16	2.22 cd	110.67 bcd
75% Wheat + 25% Common Vetch	58.36 a	33.45	62.84	2.05 d	100.00 d
25% Wheat + 75% Hungarian Vetch	60.74 a	34.97	61.65	1.99 d	95.33 d
50% Wheat + 50% Hungarian Vetch	56.25 a	29.70	65.76	2.14 d	109.67 cd
75% Wheat + 25% Hungarian Vetch	54.32 ab	32.20	63.81	2.21 cd	109.00 cd
Mean	52.55	31.98	63.99	2.33	115.89
F Value	7.15**	1.95^{ns}	1.95^{ns}	6.37**	4.62**
LSD	7.11	4.46	3.47	0.37	22.49
CV (%)	7.82	8.06	3.13	9.32	11.21

*Significant according to p<0.05, **Significant according to p<0.01, ns: not statistically significant, LSD: Minimum significant difference, CV: Coefficient of variation

The highest NDF ratio was obtained from 25% Wheat + 75% Hungarian Vetch mixture (60.74%). This was followed by 75% Wheat + 25% Common Vetch (58.36%) and 50% Wheat + 50% Hungarian Vetch (56.25%) mixtures in the same statistical group. The lowest NDF content was obtained in Pure Common Vetch (40.25%). Lower rates of NDF were obtained in pure legume plantings compared to mixed plantings. NDF is composed of cellulose, hemicellulose and lignin, which are cell wall materials in plants. Legumes have less cell wall than grasses and therefore have higher digestibility (Wilson, 1993). This is clearly seen in bare sowing. It was found that the total NDF ratio decreased in mixed plantings with vetch, which was suppressed by wheat even if its ratio in the mixture was high at the time of sowing.

The amount of ADF in plants represents the total amount of cellulose and lignin. The highest ADF rate was obtained from 25% Wheat + 75% Hungarian Vetch mixture (34.97%). This was followed by Pure Common Vetch (33.66%) and 75% Wheat + 25% Common Vetch (33.45%). The lowest ADF rate was obtained from Pure Wheat (28.09%).

In the study, the difference between the averages of digestible dry matter was statistically insignificant, while the difference between the averages of dry matter intake and relative feed value was significant. Digestible dry matter values were found between 61.65-67.02%.

The highest dry matter intake value was obtained in Pure Common Vetch (2.98%), followed by Pure Wheat (2.60%). The lowest dry matter intake value was obtained in the mixture of 25% Wheat + 75% Hungarian Vetch (1.99). Dry matter intake values are calculated using the NDF ratios of the hay in the mixture. There is an inverse relationship between dry matter consumption and NDF value. Dry matter consumption increases with a decrease in the total ratio of NDF, i.e. hemicellulose, cellulose and lignin.

Relative feed value is an index used to describe the overall value of roughages (Henning et al., 2000). Relative feed value used to determine forage quality consists of a single number. Relative feed value measure does not give information about the physical properties and protein value of the hay, but it is a good measure when used together with protein and physical properties (Ball et al, 1996). This calculated figure gives the best information about the value of the forage and is an accurate and effective way of relating the quality of the hay (Tremblay, 1998). Table 3 shows that there were statistically significant differences between the mixture ratios in terms of relative feed value. The highest relative feed value was obtained in Pure Common Vetch (145.00) and the lowest relative feed value was obtained in 25% Wheat + 75% Hungarian Vetch (95.33) mixture. Since RFV is a quality characteristic calculated using NDF and ADF values, there is an inverse relationship between them in terms of feed quality. Low ADF and NDF values resulted in high RFV values.

Conclusion

This study was conducted to determine the appropriate mixture ratios of vetch and wheat mixtures in order to meet the forage deficit of livestock producers in Kahramanmaraş province with typical Mediterranean climate characteristics. In the study in which herbage yield and quality characteristics were also examined, it was understood that mixed sowing practices were more advantageous and had superior characteristics compared to lean sowing. When the results of the study were evaluated, it was concluded that 75% Wheat + 25% Common Vetch Mixture ratio is the most suitable mixture ratio in terms of herbage yield and quality as well as more efficient use of existing ecological resources both in Kahramanmaraş and in regions with typical Mediterranean climate.

Acknowledgements

This study was financially supported by Kahramanmaraş Sütçü İmam University Scientific Research Projects Coordination Unit (Project Number: 2018/3-14 YLS).This study is a part of the master thesis of the first author (Neziha Binici).

Conflict of Interest

The authors declare that they have no conflict of interest.

Author's Contributions

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before results.

References

Açıkgöz E (2001). Forage Crops. Uludağ University, Faculty of Agriculture, Department of Field Crops, Publication No: 182, Bursa, 410p.

Anlarsal, A.E. (1987). Studies on plant and agronomic characteristics and relationships between some common vetch (Vicia sativa L.) varieties in Çukurova conditions. PhD Thesis. Ç.Ü. Institute of Science, Department of Field Crops. Adana.

Anlarsal AE, Ülgen AC, Gök M, Yücel C, Çakır B, Onaç I (1996). Determination of hay yields and nitrogen fixation of legumes in annual forage legume + corn production system in Çukurova and possibilities of reducing nitrogen use in corn production. 3rd Turkish Range-Pasture and Forage Crops Congress, 17-19 June, Erzurum, Turkey. 362-368.

Anonymous (2013). TUIK Plant Production Statistics. https://www.tuik.gov.tr/PreTablo.do?alt_id=1001, (Access Date: October 09, 2018).

Anonymous (2014). SAS V.9.3 User Guide, Copyright © 2014, SAS Institute Inc., Cary, NC, USA.

Anonymous (2018a). Kahramanmaraş Sütçü İmam University. USKIM Soil analysis Results. Kahramanmaraş.

Anonymous (2018b). Kahramanmaraş Province Meteorology Directorate Data. Kahramanmaraş.

Arslan S (2012). Effect of Different Mixtures of Vetch (Vicia sativa L.) and Barley (Hordeum vulgare L.) on Yield and Quality. Master's Thesis, Selçuk University, Institute of Science, Field Crops Department.

Avcıoğlu Ş, Avcıoğlu R (1982). A study on the yield and some other characteristics of common vetch + oat crops with different mixture ratios and cutting times. Journal of Aegean University Faculty of Agriculture 19(2): 123-136.

Avcıoğlu, R., Soya, H., Geren, H. (2000). Studies on the yield and silage possibilities of some forage crops grown as winter second crops in the Aegean region. Ege University Science Research Project No: 1998-ZRF-042, Final Result Report, 72p.

Bakoğlu A, Memiş A (2002). Determination of seed yield and some characteristics in mixtures of common vetch (Vicia sativa L.) and barley (Hordeum vulgare L.) planted at different ratios. Journal of Science and Engineering Sciences of Fırat University 14(1): 29-35.

Ball DM, Hovelend CS, Lacefield GD (1996). Forage Quality in Southern Forages. Potash & Phosphate Institute. Norcross, Georgia, pp 124-132.

Bayram G, Çelik N (1999). Studies on the effects of mixture ratios and nitrogenous fertilizer on hay yield and quality in oat (Avena sativa L.) and common vetch (Vicia sativa L.) mixed crops. Turkish III. Field Crops Congress, 15-18 November, Adana, Turkey. Volume: 3, pp 53-58.

Çaçan E, Yılmaz HŞ (2015). Effects of various Hungarian vetch (Vicia pannonica Crantz) + wheat (Triticum aestivum L.) mixture ratios on hay yield and quality in Bingöl conditions. Turkish Journal of Agricultural and Natural Sciences 2(3): 290-296.

De Wit, C. T. Van Den Bergh, J. P. (1965). Competition between herbage plants. Neth. J. Agric. Sci., 13, 212–221.

Geren, H., Avcıoğlu, R., Soya, H., Kır, B. (2007). Effect of corn (Zea mays L.) with cowpea (Vigna unguiculata L.) and bean (Phaseolus vulgaris L.) intercropping on grain yield and some yield traits in second crop conditions. Journal of Ege University Faculty of Agriculture, 44(3), 27-41.

Henning JC, Lacefield GD, Amaral-philips D (2000). Interpreting Forage Quality Reports. Cooperative Extension Service. ID-101

İptaş S, Yılmaz M (1998). Effects of different hungarian vetch + barley mixture ratios grown in Tokat conditions on yield and quality. Anadolu J. of Agri 8(2): 106 – 114.

Kaçar, B. (1972). Chemical analyses of plants and soil II. Plant analyses. Ankara University Press, Ankara, 646p.

Korkmaz A, Gülser C, Manga İ, Sancak C (1993). Effects of planting system and cutting times on mineral content and quality of grass obtained from forage plants in Samsun region. Turkish Journal of Agriculture and Forestry 17(1): 1069-1081.

Kutlu, H.R. (2008). Methods of feed evaluation and analysis. Çukurova University Faculty of Agriculture, Department of Animal Science, Lecture Notes, Adana, 65p.

Pekşen E, Gülümser A (1995). Importance of Mixed Cropping in Black Sea Region Agriculture and Usability of Some Legumes and Grasses in Mixed Cropping. Congress on New Techniques for the Development of Agriculture in the Black Sea Region, 10-11 January, Samsun, Turkey. pp. 307-315.

Serin Y, Tan M, Öztürk N (1999). A study on the fertilization of vetch + wheat mixtures. 3rd Turkish Field Crops Congress, Volume III. Range Pasture Forage Crops Food Grain Legumes, 15-18 November, Adana, Turkey. pp. 47-52,

Sheaffer C.C., Peterson M.A., Mccalin M., Volene J.J., Cherney J.H., Johnson K.D., Woodward W.T. Viands D.R. (1995). Acid detergent fibre, neutral detergent fibre concentration and relative feed value. North American Alfalfa Improvement Conference, Minneapolis.

Tan M, Serin Y (1996). A study on the investigation of macronutrient element compositions of vetch + cereal mixtures at different mixing ratios and different cutting times in Erzurum irrigated conditions. 3rd Turkish Range Pasture and Forage Crops Congress, 17-19 June, Erzurum, Turkey.

Tremblay M (1998). A Tool for Determining Alfalfa Quality. Saskatchewan Agriculture and Food. Saskatchewan.

Van Soest, P.J. (1994). Nutritional ecology of the ruminant (2nd Ed.). Ithaca, N.Y. Cornell University Pres.

Wilson J.R. (1993). Organization of Forage Plant Tissues., In H.G. Jung, D.R. Buxton, R.D. Hatfield, and J. Ralph, eds. Forage cell wall structure and digestibility. ASA-CSSA-SSSA, Madison, USA. p. 1- 32.

Yağbasanlar, T. (1987). Studies on the main agronomic and quality traits of seven triticale cultivars of different origin grown at different planting dates in bottom and barren conditions of Çukurova. PhD Thesis. Çukurova University, Institute of Science, Department of Field Crops. Adana.

Yolcu, H., Daşçı, M. and Tan, M. (2009). Determination of yield and some characteristics of forage pea + cereal mixtures planted at different rates. 8th Turkish Field Crops Congress, 19-22 October 2009, 846-849, Hatay.

Yücel C, Avcı M, Kılıçalp N, Gültekin R (2012). Evaluation of some common vetch (Vicia sativa L.) lines in terms of hay yield and hay quality in Çukurova conditions. Anatolian Journal of Agricultural Sciences 28(3): 134-140.