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Effects of Seed Rates on Forage Production, Seed Yield and Hay Quality of Annual Legume–Barley Mixtures

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Abstract: The forage yield and quality of common vetch, grasspea and barley grown alone and as mixtures were investigated in field experiments conducted at the Faculty of Agriculture, Gaziosmanpaşa University, in 2001 and 2002. The highest green forage (39.65 t ha^{-1}) and dry matter yields (10.71 t ha^{-1}) were obtained from the mixture including 25% common vetch and 75% barley, while the highest total seed yield (2.95 t ha^{-1}) was obtained from the mixture including 25% grasspea and 75% barley. In addition, the highest crude protein yield (1.53 t ha^{-1}) was achieved with the 50% grasspea and 50% barley mixture. The mean relative yield total values of dry matter and total seed yields were 1.78 and 1.79, respectively. In conclusion, the mixture comprising 25% common vetch or grasspea and 75% barley is recommended for green forage, dry matter and seed yields. The 50% grasspea and 50% barley mixture produced the highest crude protein yield and therefore is recommended for this region.

Key Words: Vetch-barley mixture, grasspea-barley mixture, forage quality

Tohum Miktarlarının Yıllık Baklagil - Arpa Karışımlarının Ot ve Tohum Verimleri ile Ot Kalitesine Etkileri

Özet: 2001 ve 2002 yıllarında Gaziosmanpaşa Üniversitesi Ziraat Fakültesi deneme tarlalarında yürütülen çalışmada adi fiğ, mürdümük ve arpanın yalın ekimleri ile baklagil ve arpa ikili karışımlarının ot verimi ve kalitesi araştırılmıştır. Araştırma sonuçlarına göre, en yüksek toplam tohum verimi (2.95 t ha^{-1}) % 25 mürdümük ve % 75 arpa karışımından elde edilirken, en yüksek yaş ot (39.65 t ha^{-1}) ve kuru madde verimi (10.71 t ha^{-1}) % 25 adi fiğ ve % 75 arpa karışımından elde edilmiştir. Ayrıca, en yüksek ham protein verimi (1.53 t ha^{-1}) % 50 mürdümük ve % 50 arpa karışımından alınmıştır. Kuru madde ve tohum verimlerinin ortalama oransal verim toplamları (RYT) sırasıyla 1.78 ve 179 olarak tespit edilmiştir. Sonuç olarak, % 25 adi fiğ yada mürdümük ve % 75 arpa karışımının yaş ot, kuru madde ve tohum verimi için, % 50 mürdümük ve % 50 arpa karışımının ise ham protein verimi açısından bölgeye tavsiye edilebilir nitelikte olduğu görülmüştür.

Anahtar Sözcükler: Fiğ-arpa karışımı, mürdümük-arpa karışımı, yem kalitesi.

Introduction

The overgrazing of natural rangelands has led to severe degradation resulting in feed shortages. These shortages are particularly acute during the late summer and early winter (Büyükburç, 1996). They can be alleviated by growing suitable annual legume-cereal mixtures on the existing fallows in rotation with cereal crops. Annual legumes and cereals such as common vetch, hairy vetch, grasspea, oat, barley and triticale are possibly the most viable fodder sources. In addition, mixtures produce higher fodder yields than pure stands. The forage quality of cereal hay is generally lower than that required to meet production goals for many livestock classes, whereas annual legume-cereal mixtures are important protein and carbohydrate sources for livestock. Açıkgöz and Çakmakçı (1986) reported that the mean crude protein yields were between 0.496 and 0.873 t ha^{-1} with common vetch + cereal mixtures under the conditions of Bursa. The experiments conducted with common vetch + triticale mixtures under the conditions of Çukurova by Tükel et al. (1997) showed that the mean dry matter yields varied between 0.98 and 2.69 t ha^{-1} and crude protein yields were between 0.54 and 0.98 t ha^{-1}. Tan and Serin (1996) reported that the average crude protein yield between 0.529 and 0.583 t ha^{-1} with

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common vetch + barley mixtures under Erzurum conditions. Arslan and Gülcan (1996) obtained mean green forage yields between 15.806 and 27.819 t ha^{-1} with common vetch + barley mixtures under the conditions of the Southeastern Anatolia region. In experiments conducted with a wheat-hairy vetch mixture, Roberts et al. (1989) obtained mean dry matter yields between 5.1 and 8.3 t ha^{-1}. Rauber et al. (2000) reported that the grain yield of pea and oats averaged 4.9 t ha^{-1} in monocultures and 5.5 t ha^{-1} in mixtures under German conditions. Altınok and Hakyemez (2002) obtained green forage yields between 22.82 and 43.66 t ha^{-1} (mean 36.76 t ha^{-1}) and dry matter yields between 5.49 and 12.74 tha (mean 9.74 t ha^{-1}) with hairy vetch + barley mixtures under Ankara conditions.

The objective of this study was to determine the suitable mixture rate of legumes and barley grown under Tokat ecological conditions.

Materials and Methods

This study was conducted in the experimental area of the Field Crop Department, Faculy of Agriculture, Gaziosmanpaşa University in 2001 and 2002. Climatic data for the research area are given in Table 1.

The experimental soils were alkaline (pH 8.04), medium in calcium carbonate (10.9%) and low in P (63 kg ha^{-1} P_2O_5), high in K_2O (534 kg ha^{-1}) and poor in organic matter (1.45%). Common vetch (*Vicia sativa* L.) cv. "Kubilay-82", barley (*Hordeum vulgare* L.) cv. "Bülbül-89"and grasspea (*Lathyrus sativus* L.) line 455 were used. Field experiments started on 20th and 23rd March, 2001 and 2002, and were designed in a factorial randomized complete block with three replications. Pure common vetch, grasspea and barley, 1/4 vetch and 3/4 barley, 2/4 vetch and 2/4 barley, 3/4 vetch and 1/4 barley, 1/4 grasspea and 3/4 barley, 2/4 grasspea and 2/4 barley, 3/4 grasspea and 1/4 barley mixtures were sown. The mixtures were sown in alternative rows. Each plot was 6 m^2 with six rows 5 m long and 0.20 m apart, and half of each plot was used to measure the forage yield and the other half to measure the grain yield. Measurements and harvesting were performed after taking out one row from each side of the plots and a 0.5 m area from the beginning of each row. Seeding rates of pure vetch, grasspea and barley were 100 kg ha^{-1}, 120 kg ha^{-1} and 200 kg ha^{-1}, respectively. N-P fertilizer, 30 kg ha^{-1} N and 80 kg ha^{-1} P_2O_5, were uniformly applied to soil before sowing.

Forage was harvested when the legume plants reached the early pod formation stage. Subsamples were dried at 70 °C for 48 h to determine dry matter yield. The second halves of the plots were harvested at maturity for grain yields. Crude protein analyses were determined on ground subsamples of legume and barley hays. The nitrogen concentration of the hay was determined by the micro-Kjeldahl procedure described by Nelson and Sommers (1973), and crude protein concentration was calculated (N x 6.25). Crude protein yield was calculated by multiplying dry matter yield by crude protein concentration.

Then relative yield total (RYT) was calculated for the mixture using the formula below (Hatipoğlu and Tükel 1997; Rauber et al. 2000) where R = O/M, R = Relative yield, O = Yield of a species in the mixture, and M = Pure sowing yield of a species.

Table 1. Meteorological data of the study area*.

	Years	March	April	May	June	July	Tot/Mean
Mean	2001	11.3	13.5	14.4	20.2	23.6	16.6
Temperature	2002	9.3	11.1	15.6	18.8	23.2	15.6
(°C)	1962-88	7.1	12.5	16.3	19.5	21.5	15.4
Rainfall	2001	19	40	58	6	1	124
(mm)	2002	29	68	92	17	38	244
	1950-88	41	64	60	39	11	215

* Source: Data of Rural Services Research Institute, Tokat, 2000.

RYT = RX + RY, RYT = Relative yield total, RX = Relative yield of X species, RY = Relative yield of Y species

The data were analyzed by analysis of variance (ANOVA) using MSTAT statistical software. Duncan's multiple range test was used to compare the different treatments.

Results and Discussion

Green forage yield

Highly significant differences were found in green forage yield: 4.25 t ha^{-1} to 32.78 t ha^{-1} in the first year and from 9.56 t ha^{-1} to 51.86 t ha^{-1} in the second year (Table 2). Average green forage yield varied from 6.90 for pure vetch to 39.65 for 25% vetch + 75% barley (Table 2). Rynolds et al. (1982), Tan and Serin (1996), Tükel et al. (1997), and Kökten and Tansı (1999) indicated that the most suitable forage production was a 25% vetch and 75% cereal mixtures. While these results confirm the findings of some researchers (Soya et al., 1999; Arslan and Gülcan, 1996), they were lower than the findings reported by Altınok and Hakyemez (2002). These differences might be caused by the ecological conditions, such as precipitation and temperature recorded during the vegetative growth cycle, and the cultivars used in the experiment. Precipitation and temperature values in the vegetative growth period of this experiment were lower, resulting in a lower yield than that in the above-mentioned experiment. In addition, the differences between the yield values of the studies might be the result the running time of the experiments (summer or winter sowings) and/or the differences in mixture rates of legume and barley plants. Mean green forage yields obtained from the pure annual legumes were lower than those from pure barley and mixtures. Similar findings have been obtained by Arslan and Gülcan

Table 2. Green forage yield, dry matter yield and total seed yield for pure and mixture sowings at Tokat in 2001 and 2002. V: Common vetch, G: Grasspea, B: Barley.

Pure and mixture sowings	Green forage yield (t ha^{-1})			Dry matter yield (t ha^{-1})			Total seed yield (t ha^{-1})		
	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
100% V	4.25 d*	9.56 f*	6.90 d*	0.97 d*	2.05 e*	1.51 d*	0.62 d*	0.68 c*	0.65 e*
100% G	7.17 d	15.74 ef	11.45 d	1.52 cd	2.99 de	2.26 d	0.75 d	1.10 bc	0.93 de
100% B	19.17 c	26.50 de	22.84 c	4.80 bc	6.57 cd	5.69 c	1.22 cd	1.65 bc	1.43 cd
75% V 25% B	19.50 c	34.22 bcd	26.86 c	4.49 bc	7.90 bc	6.20 c	1.23 cd	1.82 b	1.52 c
50% V 50% B	30.56 ab	28.39 cde	29.47 bc	7.71 ab	7.92 bc	7.81 bc	1.52 bc	2.84 a	2.18 b
25% V 75% B	32.78 a	46.52 ab	39.65 a	9.04 a	12.39 ab	10.71 a	2.10 ab	3.52 a	2.81 a
75% G 25% B	24.33 bc	47.00 ab	35.67 ab	4.80 bc	11.32 ab	8.06 bc	1.51 bc	2.78 a	2.14 b
50% G 50% B	19.50 c	51.86 a	35.68 ab	4.32 bc	13.34 a	8.83 ab	2.11 ab	3.05 a	2.58 ab
25% G 75% B	28.94 ab	42.97 abc	35.96 ab	7.22 ab	11.35 ab	9.29 ab	2.38 a	3.51 a	2.95 a
Mean	20.69 b++	33.64 a	27.16	4.99 b+	8.43 a	6.71	1.49 b+	2.33 a	1.91
LSD	7.26	14.66	7.67	3.08	4.24	2.46	0.64	0.94	0.53

* Values with the same letters (within a column) do not differ significantly ($P < 0.01$) according to Duncan's test.

\+ Values with the same letters (within a line) do not differ significantly ($P < 0.05$) according to Duncan's test.

++ Values with the same letters (within a line) do not differ significantly ($P < 0.01$) according to Duncan's test.

(1996) with vetch + barley mixtures. Due to the higher precipitation in 2002, the mean green forage yields of mixtures were higher than those of 2001 (Table 2). In general, mixtures gave higher green forage yields than the pure stands. The same has been reported by other researchers (Osman and Nersoyan, 1985; Tükel et al., 1997; Altınok and Hakyemez, 2002). In addition, the average green forage yield obtained from the pure barley plots is not statistically different from the average green forage yields obtained from the mixtures (75% vetch + 25% barley and 50% vetch + 50% barley). Similar findings have been obtained by Tükel et al. (1997) with vetch + triticale mixtures.

Dry matter yield

The dry matter yields of the pure sowings and mixtures were significantly different ($P < 0.01$) in both years (Table 2). In the first year, the highest dry matter yield (9.04 t ha^{-1}) was obtained from the mixture containing 25% vetch and 75% barley, and the lowest yield (0.97 t ha^{-1}) was obtained from the pure vetch sowing (Table 2). Dry matter yield varied from 2.05 t ha^{-1} to 13.34 t ha^{-1} in the second year. According to the two-year average, the lowest dry matter yield (1.51 t ha^{-1}) was obtained from pure vetch, and the highest (10.71 t ha^{-1}) was obtained from the mixture containing 25% vetch and 75% barley (Table 2). Rynolds et al. (1982), Tükel et al. (1997), and Kökten and Tansı (1999) indicated that the most suitable mixture for forage production was 25% legume and 75% cereal. Although Roberts et al. (1989), Tükel et al. (1997) and Soya et al. (1999) found similar results, Altınok and Hakyemez (2002) reported higher results for the same treatments. These differences might have been caused by the ecological conditions, such as precipitation and temperature, recorded during the vegetative cycle of growth, and the cultivars used in the experiment. Precipitation and temperature values in the vegetative growth period of this experiment were lower, and the resulting yield was lower than that of the experiment run by Altınok and Hakyemez (2002). In addition, the differences between the yield values of the studies might have resulted from the running time of the experiments (summer or winter sowings) and/or the differences in the mixture rates of legume and barley plants. Due to the higher precipitation in 2002, the mean dry matter yields of mixtures were higher than those in 2001 (Table 2). The mixtures gave higher yields than the pure sowings. Similar results were reported by Rynolds et al. (1982) and Osman and Nersoyan (1985). The average dry matter yield of pure barley was not statistically different from those of the mixtures. Tükel et al. (1997) reported similar results from cereal-annual legume mixtures.

Total seed yield

The total seed yields of pure and mixed sowings were significantly different in both years (Table 2). Total seed yields varied from 0.62 t ha^{-1} of vetch to 2.38 t ha^{-1} of barley in a mixture in 2001, and from 0.68 t ha^{-1} of vetch to 3.52 t ha^{-1} of barley in a mixture in 2002 (Table 2). The average total seed yield varied from 0.65 t ha^{-1} for pure vetch to 2.95 t ha^{-1} of barley for the 25% grasspea and 75% barley mixture (Table 2). These results are lower than the findings of some researchers (Tükel et al., 1997; Rauber et al., 2000). Ecological conditions, such as precipitation and temperature, as well as the different cultivars used in the field experiments could cause such differences. The mean total seed yield in the first year (1.49 t ha^{-1}) was smaller than that in the second year (2.33 t ha^{-1}) (Table 2). In the first year, the low seed production was probably related to the delayed appearance of floral buds, corresponding with the onset of drought periods (low precipitation) in the late spring, particularly in May and the beginning of June, causing high abortion rates in flowering and young pods after fertilization. This is the case because drought periods in spring (onset of flowering, fertilization and pod development stage) were the main reason for the low seed yield. Ahlgren (1956) indicated that the critical period for forage legumes in terms of water need is from the beginning of flowering to seed formation. Yield is going to be low even if the water requirement is met after this critical period.

Crude protein concentration in hay

The crude protein concentrations of the pure and mixture sowings were significant ($P < 0.01$) in both years (Table 3).

The lowest crude protein concentration was obtained from pure barley while the highest crude protein concentration was obtained from pure grasspea in both years (Table 3). According to the 2-year average, pure grasspea had the highest crude protein concentration, averaging 20.66%, while pure barley had the lowest, averaging 9.77% (Table 3). Similarly, Altınok and Hakyemez (2002) found that a vetch-barley mixture yield

Table 3. Crude protein concentration, crude protein yield, relative yield totals for dry matter yield and relative yield totals for seed yield for pure and mixture sowings at Tokat in 2001 and 2002. V: Common vetch, G: Grasspea, B: Barley.

Pure and mixture sowings	Crude protein concentration (%)			Crude protein yield (t ha^{-1})			Relative yield total for dry matter yield			Relative yield total for seed yield		
	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
100% V	19.25 b*	18.48 b*	19.22 b*	0.19 d*	0.38 d*	0.29 c*	-	-	-	-	-	-
100% G	21.89 a	19.43 a	20.66 a	0.33 cd	0.58 cd	0.46 c	-	-	-	-	-	-
100% B	10.64 g	8.91 i	9.77 h	0.51 bcd	0.59 cd	0.55 c	-	-	-	-	-	-
75% V 25% B	17.90 c	15.83 e	16.86 d	0.80 abc	1.25 bc	1.03 b	1.32	1.52	1.42	1.25	1.23	1.24
50% V 50% B	14.46 e	12.54 g	13.50 f	1.11 a	0.99 cd	1.05 b	1.78	1.35	1.57	1.47	1.87	1.67
25% V 75% B	11.79 f	9.82 h	10.81 g	1.06 ab	1.22 bc	1.14 ab	1.99	1.97	1.98	1.94	2.21	2.08
75% G 25% B	19.60 b	18.21 c	18.90 b	0.94 ab	2.06 a	1.50 a	1.27	2.80	2.04	1.41	1.88	1.65
50% G 50% B	18.05 c	17.01 d	17.53 c	0.78 abc	2.27 a	1.53 a	0.98	2.76	1.87	1.87	1.97	1.92
25% G 75% B	16.15 d	15.20 f	15.68 e	1.17 a	1.73 ab	1.45 ab	1.57	2.06	1.82	2.09	2.20	2.15
Mean	16.71 a^{++}	15.05 b	15.88	0.77 b^{+}	1.23 a	1.00	1.49	2.08	1.78	1.67	1.89	1.79
LSD	0.82	0.18	0.39	0.51	0.68	0.40						

* Values with the same letters (within a column) do not differ significantly ($P < 0.01$) according to Duncan's test.
$^{+}$ Values with the same letters (within a line) do not differ significantly ($P < 0.05$) according to Duncan's test.
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10.7%-17.0% crude protein. The mean crude protein concentration in 2002 was lower than that in 2001 due to the higher precipitation received (Table 3). Cox and Atkins (1979) indicated that more precipitation increased the carbohydrate/protein ratio. In addition, since the crude protein concentrations of legumes are higher than those of cereals the crude protein concentrations of the mixtures increased as the legume rate increased in the mixture (Droushiotis, 1989; Roberts et al., 1989; Tan and Serin, 1996; Altınok and Hakyemez, 2002).

Crude protein yield in hay

Significant differences were found in crude protein yields in both years (Table 3). Crude protein yield ranged from 0.19 t ha^{-1} to 1.17 t ha^{-1} in 2001, and from 0.38 t ha^{-1} to 2.27 t ha^{-1} in 2002 (Table 3). Average crude protein yield varied from 0.29 t ha^{-1} for pure vetch to 1.53 t ha^{-1} for 50% grasspea and 50% barley (Table 3). These results were higher than those reported by other researchers (Açıkgöz and Çakmakçı, 1986; Tan and Serin, 1996). Environmental conditions and the cultivars used in the trials could cause such differences. In addition, the high total dry matter yield could be another reason for the difference. Dry matter yields in this trial were higher, resulting in higher crude protein yield than in the above-mentioned experiments. Crude protein yields of the mixtures were higher than those of the pure sowings (Altınok and Hakyemez, 2002). Tükel et al. (1997) reported that the lowest crude protein yield was obtained from pure legumes.

Relative yield total values (RYT-values)

RYT values from the 2 years of the experiments are presented in Table 3. In the data averaged over the 2

years, the highest RYT value for dry matter yield (2.04) was obtained from the 75% grasspea and 25% barley mixture, while the highest RYT value for grain yield (2.15) was obtained from the 25% grasspea and 75% barley mixture. The mixtures outyielded the pure sowings with respect to dry matter (RYT = 1.78) and grain yield (RYT = 1.79). Rauber et al. (2000) reported that RYT values for dry matter and grain yields were 1.15 and 1.09 with 67% pea and 33% oat mixtures under German conditions. The RYT values for dry matter and seed yield were above 1 in both years (respectively, 1.49 and 2.08 for dry matter yield, and 1.67 and 1.89 for seed yield) as was the average of the 2-years (respectively, 1.78 and 1.79). Therefore, this means that a mixture uses environmental resources better than pure sowing, and competition between mixture components is not high (Hatipoğlu and Tükel 1997; Rauber et al., 2000).

Conclusions

Barley is a potentially promising crop component in the annual legume-cereal mixtures for forage and hay production during spring under Tokat conditions. Considering forage yield and the source of high protein concentration, the mixtures including 25% vetch and grasspea are the higher yielding mixtures. Dry matter yield, especially in the mixtures including lower rates of barley, was decreased while the crude protein concentration was increased. Mixtures 25% legume (either vetch or grasspea) and 75% barley are recommended for green forage and dry matter as well as seed yield for Tokat ecological conditions in this study. The mixtures outyielded the pure sowings with respect to dry matter (RYT = 1.78) and grain yield (RYT = 1.79). For crude protein yields, 50% grasspea and 50% barley mixture is recommended.

References

Açıkgöz, E. and S. Çakmakçı. 1986. Bursa koşullarında adi fiğ ve tahıl karışımlarının ot verimi ve kalitesi üzerinde araştırmalar. U.Ü. Zir.Fak. Derg. 5: 65-73, Bursa.

Ahlgren, G.H. 1956. Forage Crops. McGraw-Hill Book Comp. 2nd Ed., New York, Toronto, London.

Altınok, S. and H.B. Hakyemez. 2002. Ankara koşullarında tüylü fiğ ve koca fiğin arpa ile karışımlarında farklı karışım oranlarının yem verimlerine etkileri. Ankara Üniversitesi Tarım Bilimleri Dergisi, 8: 45-50.

Arslan, A. and H. Gülcan. 1996. Güneydoğu Anadolu Bölgesinde kışlık ara ürün olarak yetiştirilen değişik fiğ + arpa karışımlarında biçim zamanının ot verimi ve bazı tarımsal özelliklere etkisi üzerinde bir araştırma. Türkiye 3. Çayır-Mer'a ve Yembitkileri Kongresi, 17-19 Haziran, 341-347, Erzurum.

Büyükburç, U. 1996. Türkiye'de mer'a, çayır ve yembitkileri ile diğer kaba yem kaynaklarının değerlendirilmesi ve geliştirilmesine yönelik öneriler. GOÜ. Yay. Tokat, 70

Cox, G.W. and M.D. Atkins. 1979. Agricultural Ecology. W.H. Freeman and Company, San Francisco.

Droushiotis, D.N. 1989. Mixtures of annual legumes and small-grained cereals for forage production under low rainfall. Journal of Agricultural Science 113: 249-253.

Hatipoğlu, R. and T. Tükel. 1997. Tarımsal ekosistemlerde bitkiler arasındaki rekabet. Ç.Ü.Z.F. Dergisi, 12: 177-186.

Kökten, K. and V. Tansı. 1999. Research on the possibilities of growing chickling mixtures with different cereals species under Cukurova conditions. III. Turkey Field Crops Congree. November 15-18, Adana, 207-212.

Nelson, D.W. and L.E. Sommers. 1973. Determination of total nitrogen in plant material. Agronomy Journal 65: 109-112.

Osman, A.E. and N. Nersoyan. 1985. Annual legumes for integrating rainfed crop and livestock production. Proceedings. XVth International Grassland Congress 5: 123-125.

Rauber, R., K. Schmidtke and H. Kimpel-Freund. 2000. Konkurrenz und ertragsvorteile in gemengen aus erbsen (*Pisum sativum* L.) und hafer (*Avena sativa* L.). Journal of Agronomy and Crop Science 185: 33-47.

Roberts, C.A., K.I. Moore and K.D. Johnson. 1989. Forage quality and yield of wheat-vetch at different stages of maturity and vetch seeding rates. Agronomy Journal 81: 57-60.

Rynolds, M.P., K.D. Sayre and H.E. Vivar. 1982. Intercropping wheat and barley with N fixing legume species: A method for improving ground cover, N-use efficiency and productivity in low input systems. Journal of Agricultural Science. 123: 175-183.

Soya, H., Ş. Gülenç, R. Avcıoğlu and H. Geren. 1999. Kışlık ikinci ürün olarak tüylü fiğin arpa ile karışımlarında değişik hasat dönemlerinin verim ve verim özelliklerine etkileri üzerinde araştırmalar. Türkiye 3. Tarla Bitk. Kon. 15-18 Kasım, 59-62, Adana.

Tan, M. and Y. Serin. 1996. Değişik fiğ + tahıl karışımları için en uygun karışım oranı ve biçim zamanının belirlenmesi üzerinde bir araştırma. Atatürk Üniv. Zir. Fak. Der. 27: 475-489.

Tükel, T., E. Hasar and R. Hatipoğlu. 1997. Effect of mixture rates and cutting dates on the forage yield and quality of vetch-triticale mixtures and their seed yields under lowland conditions of Çukurova. XVIIIrd International Grassland Congress, June 8-19, Canada, 25-26.