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The Amount of NO_3^--N Transferred to Soil by Legumes, Forage and Seed Yield, and the Forage Quality of Annual Legume + Triticale Mixtures*

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Abstract: The forage yield and quality of hairy vetch, grasspea and triticale grown alone and as mixtures of legume + triticale were investigated in field experiments conducted in the fields of the Faculty of Agriculture of Gaziosmanpaşa University in 1998-1999 and 1999-2000. The highest dry matter (10.06 t/ha) and crude protein yields (1.56 t/ha) were obtained from the mixture including 50% Line-452 of grasspea + 50% triticale. On the other hand, the highest seed yield (5.38 t/ha) was achieved from the 50% Line-38 of grasspea + 50% triticale mixture. The amount of NO_3^--N transferred to the soil by legumes (0.079 t/ha) was highest in the pure sowing of hairy vetch, whereas crude protein content was highest in the pure Line-38 of grasspea. In addition, the highest crude fiber (26.32%) and crude ash contents (17.28%), and crude fiber (2.50 t/ha) and crude ash yields (1.61 t/ha) were obtained from the 50% hairy vetch + 50% triticale mixtures. In conclusion, the 50% Line-452 of grasspea + 50% triticale mixture is recommended for dry matter and crude protein yields. The 50% Line-38 of grasspea + 50% triticale mixture produced the best seed yield and so it is recommended for this purpose in this region.

Key Words: Hairy vetch-triticale, grasspea-triticale, mixtures, feed quality

Tekyıllık Baklagil + Tritikale Karışımlarının Ot ve Tohum Verimi, Ot Kalitesi ve Baklagiller Tarafından Toprağa Nakledilen NO_3^--N Miktarı Üzerine Bir Araştırma

Özet: 1998-1999 ve 1999-2000 yıllarında Gaziosmanpaşa Üniversitesi Ziraat Fakültesi deneme tarlalarında yürütülen çalışmada tüylü fiğ, mürdümük ve tritikalenin yalın ekimleri ile baklagil + tritikale ikili karışımlarının ot verimi ve kalitesi araştırılmıştır. Araştırma sonuçlarına göre, en yüksek kuru madde verimi (10.06 t/ha) % 50 452 No'lu mürdümük + % 50 tritikale karışımından, en yüksek tohum verimi (5.38 t/ha) % 50 38 No'lu mürdümük hattı + % 50 tritikale karışımından alınmıştır. Ayrıca, baklagiller tarafından toprağa transfer edilen en yüksek NO_3^--N miktarı (0.079 t/ha) tüylü fiğin saf ekiminden elde edilmiştir. En yüksek ham protein oranı (% 22.50) saf 38 No'lu mürdümük hattından ve en yüksek ham protein verimi (1.56 t/ha) ise % 50 452 No'lu mürdümük + % 50 tritikale karışımından alınmıştır. Öte yandan, en yüksek ham selüloz oranı (% 26.32) ve ham kül oranı (% 17.28); % 50 tüylü fiğ + % 50 tritikale karışımından alınmıştır. Ayrıca, en yüksek ham selüloz verimi (2.50 t/ha) ve ham kül verimi (1.61 t/ha) % 50 tüylü fiğ + % 50 tritikale içeren karışımlardan elde edilmiştir.

Anahtar Sözcükler: Tüylü fiğ-tritikale, mürdümük-tritikale, karışımlar, yem kalitesi

Introduction

The overgrazing of natural rangelands has led to severe degradation resulting in feed shortage. These shortages are particularly acute during 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 hairy vetch (*Vicia villosa* Roth.), Hungarian vetch (*Vicia pannonica* Crantz.), grasspea (*Lathyrus sativus* L.), oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.) and triticale (*Triticosecale Wittmack*) could be the most viable fodder sources. In addition, mixtures produce more fodder yield than pure stands. The forage quality of cereal hay is generally

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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. Hryncewicz et al., (1973) reported that dry matter yield was 5690 kg/ha with wheat + hairy vetch and 6530 kg/ha with rye + hairy vetch. The experiments conducted with hairy vetch + rye mixtures under Polish conditions by Bernstein (1974) showed that the dry matter and crude protein yields were 5580 kg/ha and 1150 kg/ha, respectively. Korenev et al., (1978) obtained a mean dry matter yield of 5350 kg/ha with a hairy vetch + wheat mixture. Arce et al., (1979) reported that the mean dry matter yield was 9400 kg/ha with hairy vetch + oat mixtures under Bolivian conditions. In an experiment conducted with common vetch + cereal mixtures under Bursa conditions, the average dry matter yield and crude protein yield varied between 6355-8997 kg/ha and 479.5-835.8 kg/ha, respectively (Açıkgöz and Çakmakçı, 1986). In another experiment conducted with common vetch + triticale mixtures by Aydın and Tosun (1991) under Samsun ecological conditions, the mean dry matter yields varied between 1229 and 2210 kg/ha and crude protein yields between 121.5 and 386.1 kg/ha. In an experiment conducted with common vetch + triticale mixtures under Bornova conditions, Soya et al., (1991) reported that the mean dry matter yields were between 3700 and 4560 kg/ha, crude protein yields between 744 and 956 kg/ha, crude ash yields between 503 and 526 kg/ha, and crude fiber yields between 832 and 933 kg/ha in 1989 and 1990, respectively. Konak et al., (1997) reported that the mean crude ash yields varied between 2980 and 11180 kg/ha with common vetch, barley, oats and triticale grown alone and as a mixture of common vetch + cereal. On the other hand, in an experiment conducted by Tükel et al., (1997) under lowland conditions in Çukurova, the mean dry matter yields varied between 3.92 and 8.46 t/ha, seed yields between 0.98 and 2.69 t/ha and crude protein yields between 0.54 and 0.98 t/ha. Hatipoğlu et al., (1999) reported that the mean dry matter yields varied between 4912 and 9684 kg/ha and crude protein yields between 788 and 1109 kg/ha with common vetch + triticale under Diyarbakır conditions.

The aim of this study was to determine the suitability of triticale in mixtures with grasspea and hairy vetch under Tokat ecological conditions.

Materials and Methods

This study was conducted at the Tokat Agricultural Faculty Research Station (altitude 608 m). Average temperature in the growing season (November-July) was 10.2 °C, the highest temperature was recorded as 24.6 °C, in July. The lowest temperature was recorded as –0.8 °C, in January. Precipitation in the second year's growing season (412.60 mm) was much higher than that in the first year (355.10 mm) and in the long term (383.90 mm) (Table 1). Soils at the experiment location were alkaline, unsalted and poor in organic matter and P_2O_5, but rich in K_2O. Local cultivars of hairy vetch called "Menemen-79", of triticale called "Tatlıcak-97"and Line 452 and Line 38 of grasspea were used as plant materials.

The field trials started on 1-3 November of 1998 and 1999 and were carried out in a factorial randomized complete block design with three replications. Sowing plots were designated as pure stands Line 452 of grasspea, pure Line 38 of grasspea, hairy vetch, triticale, and as mixtures 1/2 pure Line 452 of grasspea + 1/2

Table 1. Meteorological data at Agricultural Faculty Research Station Tokat, in 1998-1999 and 1999-2000 growing seasons.

	Years	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Tot/Mean
Mean	1998/99	6.3	4.5	4.1	6.2	7.9	12.8	16.1	20.7	23.7	11.37
temperature	1999/00	7.3	5.2	-0.8	0.5	5.7	15.0	14.9	18.7	24.6	10.12
(°C)	Long term	7.0	3.3	1.4	2.7	6.9	12.5	16.4	19.6	22.0	10.20
Rainfall	1998/99	29.3	71.8	14.4	53.0	34.8	67.9	47.2	34.8	1.9	355.10
(mm)	1999/00	24.4	32.0	56.0	62.2	36.9	91.6	88.9	14.5	6.1	412.60
	Long term	48.1	47.3	41.3	33.1	39.7	62.0	61.1	40.5	10.8	383.90

Köy Hizmetleri Araştırma Enstitüsü, Tokat, 2000.

triticale, 1/2 pure Line 38 of grasspea + 1/2 triticale, and 1/2 vetch + 1/2 triticale. Mixtures were sown in alternate rows. The area of each plot was 8.75 m2. Seed sowing ratios were calculated using Gençkan's formula (1985). The sowing rates of pure stands of grasspea, vetch and triticale were 120 kg/ha, 80 kg/ha and 200 kg/ha, respectively. N-P fertilizer, 30 kg/ha N and 80 kg/ha P_2O_5, was uniformly applied to the soil before sowing. Half of each plot was used to measure forage yield and the other half to measure grain yield. To determine dry matter, forage was harvested when legume plants reached the pod formation stage, and subsamples were dried at 70 °C for 48 h. The remainder of each plot was harvested at maturity for grain yields. Estimations of quality parameters, crude protein, crude fiber and crude ash analysis were determined on ground subsamples of legume hays and triticale straw. Crude protein content was determined by the micro-Kjeldahl procedure described by Kaçar (1977), and crude protein content was calculated (Nx6.25). AOAC (1984) was used for crude fiber and crude ash contents. Crude protein, crude fiber and crude ash yields were calculated by multiplying dry matter yield by crude protein content, crude fiber content and crude ash contents, respectively. Soils were sampled from each plot at 60 cm with a hydraulically driven probe in 1999 and 2000. Soil NO_3^--N was determined by the electrode method on water extracts of air-dried samples (Dahnke, 1980).

All the data were subjected to analysis of variance (ANOVA) procedures using the MSTAT statistical software package. The least significant difference (LSD) test was used to compare the treatments.

Results and Discussion

Dry Matter Yield

Dry matter yields obtained from the pure sowings and the mixtures were significantly different ($p \leq 0.05$) in both years (Table 2). In the first year, the lowest dry matter yield (1.46 t/ha) was obtained from the pure Line 452 of grasspea while the highest yield (9.07 t/ha) was obtained from the 50% Line 452 of grasspea + 50% triticale mixture (Table 2). Dry matter yield varied from 5.20 t/ha to 13.59 t/ha in the second year (Table 2). According to the average of the two year's results, the lowest dry matter yield (3.34 t/ha) was obtained from the pure Line 452 of grasspea but the highest dry matter yield (10.06 t/ha) was obtained from the 50% Line 452 of grasspea + 50% triticale mixture (Table 2). While these results confirm the findings of Arce et al., (1979) and Hatipoğlu et al. (1999), the values are higher than findings of some other researchers (Hryncewicz et al., 1973; Bernstein, 1974; Korenev et al., 1978; Açıkgöz and Çakmakçı, 1986; Aydın and Tosun, 1991; Soya et al., 1991; Tükel et al., 1997). These differences might be caused by ecological factors such as precipitation and temperature during the vegetative cycle of growth and by the cultivars in the experiment. In 2000, the mean dry matter yields of mixtures were higher than yields obtained in 1999 (Table 2). This might be due to higher precipitation in 2000. Mixture yields were higher than pure sowing yields. Similar results have been reported in other studies (Aydın and Tosun, 1991). On the other hand, the average dry matter yield obtained from the pure triticale plots was not statistically different from the average dry matter yields obtained from the mixtures. Similar findings have been obtained by Robinson (1969) with oat + annual legume mixtures. Açıkgöz and Çakmakçı (1986) indicated that the most suitable forage production was obtained from 50% common vetch + 50% cereal mixtures.

Seed Yield

Seed yields of the pure sowings and the mixtures were significant in both years (Table 2). In the first year, seed yield varied from 0.84 t/ha to 4.53 t/ha and from 0.45 t/ha to 7.74 t/ha in the second year (Table 2). For the seed yield, 50% Line 38 of grasspea + 50% triticale had the highest seed yield averaging 5.38 t/ha, while the pure hairy vetch had the lowest seed yield averaging 0.71 t/ha (Table 2). These results are higher than the findings of Tükel et al., (1997). This could be due to the effects of the ecological factors such as precipitation and temperature and also the cultivars used in experiments. The mean seed yield in the first year (2.61 t/ha) was much lower than that of the second year (3.98 t/ha) (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 spring, particularly in May, resulting in high abortion rates in flowering and young pods after fertilization because drought periods in spring (onset of flowering, fertilization and pod development stage) might negatively affect the seed yield. Tosun (1974) indicated that the most important period for water requirement of

Table 2. Dry matter yield, total seed yield and soil NO_3^--N amount for pure and mixture sowings at Tokat in 1998-1999 and 1999-2000.

	Dry matter yield (t/ha)			Total seed yield (t/ha)			Soil NO_3^--N amount (t/ha)		
Pure and mixture sowings	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
100% Grasspea-Line 452	1.46 c*	5.20 c*	3.34 c**	0.84 b*	1.37 c*	1.10 b**	0.044 a**	0.074 bc**	0.059 b**
100% Grasspea-Line 38	1.52 c	5.69 c	3.61 c	0.96 b	1.42 c	1.19 b	0.042 a	0.081 b	0.061 b
100% Hairy vetch	3.20 bc	4.93 c	4.06 bc	0.96 b	0.45 c	0.71 b	0.056 a	0.103 a	0.079 a
100% Triticale	8.06 ab	6.52 bc	7.29 ab	4.53 a	4.54 b	4.54 a	-	-	-
50% Grasspea-Line 452 50% Triticale	9.07 a	11.06 ab	10.06 a	3.93 a	5.97 ab	4.95 a	0.020 b	0.058 c	0.039 c
50% Grasspea-Line 38 50% Tritilcale	5.47 abc	13.59 a	9.53 a	3.02 ab	7.74 a	5.38 a	0.026 b	0.063 bc	0.044 c
50% Hairy vetch 50% Triticale	7.69 ab	11.49 ab	9.59 a	4.04 a	6.40 ab	5.22 a	0.028 b	0.065 bc	0.047 c
Mean	5.21 b+	8.35 a	6.78	2.61 b+	3.98 a	3.30	0.036 b++	0.074 a	0.055
LSD	5.13	5.25	3.36	2.67	2.23	1.59	0.014	0.022	0.012

* Values with the same letters (with a column) do not differ significantly ($p \leq 0.05$) according to LSD test.
** Values with the same letters (with a column) do not differ significantly ($p \leq 0.01$) according to LSD test.
+ Values with the same letters (with a line) do not differ significantly ($p \leq 0.05$) according to LSD test.
++ Values with the same letters (with a line) do not differ significantly ($p \leq 0.01$) according to LSD test.

forage legumes was from the beginning of flowering to the seed formation and the yield would be low even if the water requirements of plants were met after this period.

Soil NO_3^--N Amount

Significant differences were found in the amount of NO_3^--N transferred to the soil by legumes (Table 2). Soil NO_3^--N varied from 0.020 t/ha to 0.056 t/ha in the first year and from 0.058 t/ha to 0.103 t/ha in the second year (Table 2). Average soil NO_3^--N varied from 0.039 t/ha for the 50% Line 452 of grasspea + 50% triticale mixture to 0.079 t/ha for pure hairy vetch (Table 2). In general, pure legume sowings provided higher amounts of NO_3^--N transferred to the soil than the mixture sowings.

Crude Protein Content

Differences in crude protein content were significant among the pure sowings and mixture sowings (Table 3). For the both experimental years, the lowest crude protein content was obtained from the pure triticale while the highest crude protein content was obtained from the pure Line 38 of grasspea (Table 3). The pure Line 38 of grasspea had the highest crude protein content, averaging 22.50%, while the pure triticale had the lowest, averaging 8.55% (Table 3). These findings were in line with those of previous investigations (Aydın and Tosun, 1991). In 2000, the mean crude protein content was less than that in the previous year (Table 3); this might be due to the lower precipitation in 1999. Similarly, Andiç (1993) has reported that more precipitation increased carbohydrate/protein content.

Crude Protein Yield

Significant differences were found in crude protein yields in both experimental years (Table 3). Crude protein yield ranged from 0.33 t/ha to 1.22 t/ha in the first year and from 0.50 t/ha to 2.34 t/ha in the second year (Table 3). For the average of the two year's results, the highest protein yield (1.56 t/ha) was obtained from the 50% Line 452 of grasspea + 50% triticale mixture while the lowest protein yield (0.63 t/ha) was obtained from the pure triticale sowing due to the lower protein contents of triticale (Table 3). These results were higher than the findings of some other researchers (Bernstein, 1974; Açıkgöz and Çakmakçı, 1986; Aydın and Tosun, 1991; Soya et al., 1991; Tükel et al., 1997; Hatipoğlu et al., 1999). Environmental conditions and the cultivars used in the trials could cause such a difference. In addition high total dry matter per area could result in such a difference.

Table 3. Crude protein content and crude protein yield for pure and mixture sowings at Tokat in 1998-1999 and 1999-2000.

	Crude protein content (%)			Crude protein yield (t/ha)		
Pure and mixture sowings	1999	2000	Mean	1999	2000	Mean
100% Grasspea-Line 452	22.47 a*	19.38 a*	20.92 b**	0.33 c*	1.01 bcd*	0.67 c**
100% Grasspea-Line 38	23.63 a	21.37 a	22.50 a	0.36 c	1.22 bcd	0.79 bc
100% Hairy vetch	18.20 b	16.75 b	17.48 c	0.58 bc	0.83 cd	0.71 c
100% Triticale	9.29 e	7.81 d	8.55 f	0.76 abc	0.50 d	0.63 c
50% Grasspea-Line 452 50% Triticale	13.37 c	11.54 c	12.46 d	1.22 a	1.90 ab	1.56 a
50% Grasspea-Line 38 50% Tritilcale	13.98 c	11.97 c	12.97 d	0.76 abc	2.34 a	1.55 a
50% Hairy vetch 50% Triticale	12.05 d	10.36 c	11.20 e	0.93 ab	1.70 abc	1.31 ab
Mean	16.40 a+	14.17 b	15.29	0.71 b+	1.36 a	1.03
LSD	1.21	2.07	1.10	0.48	0.99	0.55

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In fact, dry matter yields in this trial were higher, resulting in a higher yield than in the above-mentioned experiments. Furthermore, crude protein yields of the mixtures were more productive than those of pure sowings. Our results are in agreement with those of Bayram and Çelik (1999).

Crude Fiber Content

Crude fiber contents of the pure sowings and mixtures were significant ($p \leq 0.01$) in both years (Table 4). In the first year, the highest crude fiber content (27.43%) was obtained from the 50% hairy vetch + 50% triticale mixture while the lowest (18.83%) was obtained from the pure Line 38 of grasspea (Table 4). Crude fiber content varied from 17.20% to 25.20% in the second year (Table 4). The 50% hairy vetch + 50% triticale mixture had the highest crude fiber content, averaging 26.32%, while the pure line 38 of grasspea had the lowest, averaging 18.58% (Table 4).

Crude Fiber Yield

Significant differences were observed in crude fiber yield in 1999 and 2000 (Table 4). Crude fiber yields varied from 0.29 t/ha to 2.30 t/ha in the first year and from 0.90 t/ha to 3.14 t/ha in the second year (Table 4). The two year's results indicated that the 50% hairy vetch + 50% triticale mixture produced the highest crude fiber yield (2.50 t/ha), whereas the pure Line 452 of grasspea had the lowest crude fiber yield (0.60 t/ha) (Table 4). These results were higher than findings of Soya et al., (1991). These differences in crude fiber yield might be caused by the cultivars used in the field experiments and the amount of phosphorus fertilizer. Many researchers have reported that the most important factor affecting the chemical content of fodder in forages is genotype (Hacker and Minson, 1981; Marten, 1985). In addition, Miskovic et al., (1977) have reported that phosphorus fertilizers in legumes affected the chemical composition of fodder positively. As a result, crude fiber concentration increased. Soya et al., (1991) used 60 kg/ha P_2O_5 in their experiments, whereas 80 kg/ha P_2O_5 was applied in this research. This difference might be one of the reasons for our high crude fiber yield.

Crude Ash Content

There were differences between the mixtures for crude ash content in both years (Table 5). Crude ash contents varied between 6.77% and 19.53% in the first year and between 5.30% and 17.17% in the second year (Table 5). The 50% hairy vetch + 50% triticale mixture had the highest crude ash content, averaging 17.28%, while the pure triticale had the lowest percentage,

Table 4. Crude fiber content and crude fiber yield for pure and mixture sowings at Tokat in 1998-1999 and 1999-2000.

	Crude fiber content (%)			Crude fiber yield (t/ha)		
Pure and mixture sowings	1999	2000	Mean	1999	2000	Mean
100% Grasspea-Line 452	20.17 d*	17.20 e*	18.69 cd*	0.30 b*	0.90 c*	0.60 c*
100% Grasspea-Line 38	18.83 e	18.33 e	18.58 d	0.29 b	1.04 c	0.66 c
100% Hairy vetch	20.80 cd	18.77 de	19.79 c	0.67 b	0.93 c	0.80 c
100% Triticale	24.10 b	21.60 bc	22.85 b	1.96 a	1.41 bc	1.68 b
50% Grasspea-Line 452 50% Triticale	25.27 b	20.53 cd	22.90 b	2.30 a	2.28 ab	2.29 ab
50% Grasspea-Line 38 50% Tritilcale	22.00 c	23.20 ab	22.60 b	1.20 ab	3.14 a	2.17 ab
50% Hairy vetch 50% Triticale	27.43 a	25.20 a	26.32 a	2.10 a	2.89 a	2.50 a
Mean	22.66 a+	20.69 b	21.68	1.26	1.80	1.53
LSD	1.32	2.08	1.13	1.28	1.11	0.78

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\+ Values with the same letters (with a line) do not differ significantly ($p \leq 0.05$) according to LSD test.

Table 5. Crude ash content and crude ash yield for pure and mixture sowings at Tokat in 1998-1999 and 1999-2000.

	Crude ash content (%)			Crude ash yield (t/ha)		
Pure and mixture sowings	1999	2000	Mean	1999	2000	Mean
100% Grasspea-Line 452	9.40 d*	8.34 d*	8.87 c*	0.14 c*	0.44 c*	0.29 b*
100% Grasspea-Line 38	8.37 e	7.77 d	8.07 c	0.13 c	0.44 c	0.28 b
100% Hairy vetch	9.93 d	7.43 d	8.68 c	0.32 c	0.37 c	0.34 b
100% Triticale	6.77 e	5.30 e	6.04 d	0.55 c	0.34 c	0.45 b
50% Grasspea-Line 452 50% Triticale	18.37 b	12.53 c	15.45 b	1.68 a	1.39 b	1.53 a
50% Grasspea-Line 38 50% Tritilcale	14.10 c	17.17 a	15.64 b	0.77 bc	2.32 a	1.55 a
50% Hairy vetch 50% Triticale	19.53 a	15.03 b	17.28 a	1.50 ab	1.71 ab	1.61 a
Mean	12.35 a+	10.51 b	11.43	0.73	1.00	0.79
LSD	1.03	1.82	0.96	0.80	0.74	0.33

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\+ Values with the same letters (with a line) do not differ significantly ($p \leq 0.01$) according to LSD test.

averaging 6.04% (Table 5). These results were higher than the findings of Konak et al., (1997). Many researchers have reported that the chemical content of fodder in forages is affected by genotype (Hacker and Minson, 1981; Marten, 1985).

Crude Ash Yield

Differences in the crude ash yield of the pure sowings and mixture sowings were significant in 1999 and 2000 (Table 5). In 1999, the highest crude ash yield (1.68 t/ha) was obtained from the 50% Line 452 of grasspea +

50% triticale mixture, while the lowest yield was obtained (0.13 t/ha) from the pure Line 38 of grasspea (Table 4). In 2000, the highest and the lowest crude ash yields (2.32 t/ha and 0.34 t/ha, respectively) were obtained from the 50% Line 38 of grasspea + 50% triticale mixture and pure triticale (Table 5). Mean crude ash yield varied from 0.28 t/ha for pure Line 38 of grasspea to 1.61 t/ha for the 50% hairy vetch + 50% triticale mixture (Table 5). Our findings indicate higher crude ash yields than of Soya et al. (1991) and Konak et al. (1997). These differences might be caused by different cultivars used in the trials and the amount of phosphorus fertilizer. Hacker and Minson (1981) have reported that the chemical content of fodder in forages is affected by genotype. The cultivars used by Konak et al., (1997) were cv. Beaguelita and cv. Eronga of triticale and cv. Kubilay-82 of common vetch while the cultivars used in this research were cv. Menemen-79 of hairy vetch, cv. Tatlıcak-97 of triticale and Line 452 and 38 of grasspea. Moreover, it was determined that phosphorus fertilizers in legumes affected the chemical composition of fodder positively. As a result, crude ash concentration, which contains mineral matter, increased (Miskovic et al., 1977).

Conclusions

It was revealed that mixtures including 50% grasspea and hairy vetch produced higher yields than pure sowings when considering forage yield, crude protein yield, crude fiber yield and crude ash yield. In addition, our results indicated that triticale is a promising crop cereal in the annual legume + cereal mixtures for forage as well as for hay production during the winter in Tokat. Triticale produces even higher amounts of forage (as well as protein yields) than the commonly used barley and oats in the region. According to the results of this study, the 50% Line 452 of grasspea + 50% triticale mixture is recommended for dry matter and crude protein yields. The 50% hairy vetch and 50% triticale mixture produced the best crude fiber and crude ash yields and so it is recommended for this purpose in this region. In addition, for seed yield, the 50% Line 38 of grasspea and 50% triticale mixture is recommended.

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