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Forage Yields, Seed Yields and Botanical Compositions of Some Legume-barley Mixtures under Rainfed Condition in Semi-Arid Regions of Turkey

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Abstract: The forage and seed yields of common vetch (*Vicia sativa* L.), Hungarian vetch (*Vicia pannonica* Crantz.), hairy vetch (*Vicia villosa* Roth.), grasspea (*Lathyrus sativus* L.) and barley (*Hordeum vulgare* L.) grown as mixture were investigated in field experiments conducted at the Faculty of Agriculture, Gaziosmanpasa University, in 2001/02 and 2002/03. Field experiments, designed in a factorial randomized compelete block with three replications, were carried out during 2001-2002 and 2002-2003 starting in the second week of November, 2001 and 2002. The highest dry matter (14435.8 kg ha^{-1}) and total seed yields (3274.3 kg ha^{-1}) were obtained from the mixture including 34% barley and 66% grasspea line 455, while the highest green forage yield (43401.5 kg ha^{-1}) was obtained from the mixture including 34% barley and 66% Efes-79. In addition, the highest barley ratio in dry matter (95.67%) was achieved with the 34% barley and 66% Urem-79 mixture. The mixture of 34% barley and 66% Menemen-79 produced the highest legume ratio in dry matter (7.86%). The mixtures out yielded the pure barley sowing with respect to green forage, dry matter and total seed yields.

Key words: Vetch-barley mixture, grasspea-barley mixture, forage yield, total seed yield

INTRODUCTION

Traditional cereal/fallow cropping systems are used by the majority of the farmers in the arid and semi-arid regions of Turkey. Approximately 4.5-5.0 million ha of the total agricultural area in Turkey is under fallow[1]. Such areas generally receive less than 500 mm average annual precipitation and in terms of the distribution pattern typically 70% of the precipitation falls between December and May[2]. To provide better quality feed for livestock population in these areas and to improve soil fertility, annual forage legumes need to be introduced to replace fallow in the region[2-4]. Their amino acid profiles complement those of the cereal grains and therefore legume-cereal mixtures are important in both food and feed[5]. Crop mixtures clearly have may advantages and are superior to monocultures, providing greater yield and quality stability and better exploiting all the resources available through enhanced crop plasticity[6]. Moreover, annual legume-cereal mixtures have been attributed to weed, disease and insect suppression[7].

The objective of this study was to determine forage yields, seed yields and botanical compositions of some legume-barley mixtures under rainfed condition in semi-arid regions of Turkey.

MATERIALS AND METHODS

This study was conducted in the experimental area of the Field Crop Department, Faculty of Agriculture, University of Gaziosmanpasa, Tokat, Turkey (40°13′-40°22′ N, 36°1′-36°40′ E, altitude 623 m) in 2001/02 and 2002/03. Some climatic data for the research area are given Table 1. The experimental soils were slight alkaline (pH 7.80), medium in calcium carbonate content (10.0%) and in P content (80.1 kg ha^{-1}) high in K (959 kg ha^{-1}) and poor in organic matter (1.68%) content. The mixtures studied in the research were pure barley and 66% legume and 34% barley. Common vetch (*Vicia sativa* L.) cv. "Karaelci", "Urem-79" and common vetch line 845, barley (*Hordeum vulgare* L.) cv. "Bulbul-89" Hungarian vetch (*Vicia pannonica* Crantz.) cv. "Ege Beyazi", hairy vetch (*Vicia villosa* Roth.) cv. "Efes-79", "Menemen-79" and grasspea (*Lathyrus sativus* L.) lines 38, 455 and 463 were used.

Field experiments started on 15th and 16th November, 2001 and 2002 and were designed in a factorial randomized complete block with three replications. 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

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Table 1: Climatic data of the experimental area

	Years	Nov.	Dec.	Jan.	Feb.	Mar.	Ap.	May.	Jun.	Jul.	Tot/Mean
Mean	2001-02	7.4	5.1	-4.5	4.1	9.3	11.1	15.6	18.8	23.2	10.0
temperature	2002-03	6.9	-2.0	5.5	2.2	3.0	11.0	17.0	18.2	21.7	9.3
(°C)	1962-88	7.1	3.1	1.3	2.9	7.1	12.5	16.3	19.5	22.0	10.2
Rainfall	2001-02	73.4	50.5	45.1	20.4	29.2	68.4	16.8	57.6	37.6	399.0
(mm)	2002-03	33.8	25.0	27.8	21.8	16.4	73.7	11.8	11.4	1.4	223.1
	1950-88	50.1	47.2	41.7	33.4	40.2	63.7	60.3	39.4	10.8	386.8

Data of Rural Services Research Institute, Tokat, 2003

the grain yield. Measurements and harvesting were performed after taking out one row from each side of the plots and 0.5 m area from the beginning of each row. Seeding rates of pure common vetch, Hungarian vetch, hairy vetch, grasspea and barley were 100, 80, 80, 120 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. The second halves of the plots were harvested at maturity for grain yields. Subsamples were dried at 70°C for 48 h to determine dry matter yield.

Analysis of variance and Duncan analysis for mean comparisons were conducted as outlined by Gomez and Gomez[8]. Results from the two years were combined and analyzed as a factorial randomized complete block.

RESULTS AND DISCUSSION

Green forage yield: Significant differences were found in green forage yield in both years (Table 2). Green forage yield varied from 30555.7 to 47343.3 kg ha^{-1} in the first year and from 19583.3 to 40277.7 kg ha^{-1} in the second year (Table 2). Average green forage yield varied from 25069.5 kg ha^{-1} for pure barley sowing to 43401.5 kg ha^{-1} for 34% barley and 66% Efes-79 mixture (Table 2). While these results confirm the findings of some other researchers[9,10], these results have been found lower than findings of Tukel and Hatipoglu[11]. These differences might be originated by ecological conditions such as precipitation and temperature recorded during the vegetative growth cycle and cultivars in the experiments. Due to the higher precipitation in 2002, the mean green forage yields of mixtures were higher than those of in 2003 (Table 2). The mixtures gave higher yields than the pure sowing. The same has been reported by other researchers [12,13].

Dry matter yield: Differences of dry matter yields of the mixture sowings were significant at 1% level of probability in the first year but significant at 5% level of probability in the second year (Table 2). In 2002, the lowest dry matter yield (8346.3 kg ha^{-1}) was obtained from the pure barley sowing while the highest yield (18767.7 kg ha^{-1}) was obtained from the 34% barley and 66% grasspea line 455 mixture (Table 2). In 2003, dry matter yield varied from 6423.0 kg ha^{-1} for pure barley to 12840.0 kg ha^{-1} for 34% barley and 66% Urem-79 mixture (Table 2). According to the two-year average, the lowest dry matter yield (7384.7 kg ha^{-1}) was obtained from the pure barley and the highest dry matter yield (14435.8 kg ha^{-1}) was obtained from the mixture containing 34% barley and 66% grasspea line 455 (Table 2). While these results found similar results of Altinok and Hakyemez[10], these results have been found higher than findings of some other researchers[14,15]. These differences may have arisen from environmental conditions such as precipitation and temperature recorded during the vegetative cycle of growth and the cultivars in the experiment. Due to the higher precipitation in 2002, the mean dry matter yields of mixtures were higher yields than the pure stand. Similar results were reported by Al-Masri[16] and Rauber *et al.* [17].

Total seed yield: The total seed yields were not significant different in both years (Table 2). Total seed yields ranged from 2447.0 to 3882.0 kg ha^{-1} in the first year and from 1818.3 to 2706.0 kg ha^{-1} in the second year (Table 2). The average total seed yield ranged from 2132.7 kg ha^{-1} for pure barley to 3274.3 kg ha^{-1} for 34% barley and 66% grasspea line 455 mixture (Table 2). Rauber *et al.* [17] found higher results from the same treatments. Environmental conditions such as precipitation and temperature and cultivars in the field experiments could cause such a difference. The mean seed yield in the first year (3369.0 kg ha^{-1}) was higher than that of the second year (2351.0 kg ha^{-1}). In the second 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. Heath *et al.* [18] reported that critical period for forage legumes in terms of water need is from the beginning of flowering to seed formation. Yield could be low even if the water requirement is met after this critical period.

Table 2: Green forage yield, dry matter yield and total seed yield for mixture sowings at Tokat in 2002 and 2003. Karaelci and Urem-79 cultivars: Common vetch, Ege Beyazi cultivar: Hungarian vetch, Efes-79 and Menemen-79 cultivars: Hairy vetch

	Green forage yield (kg ha^{-1})			Dry matter yield (kg ha^{-1})			Total seed yield (kg ha^{-1})		
Mixture sowings	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean
100% Barley	30555.7b*	19583.3b*	25069.5b**	8346.3c**	6423.0b*	7384.7b**	2447.0	1818.3	2132.70b*
34% Barley									
66% Karaelci	33541.7ab	29722.3a	31632.0ab	11116.3bc	9556.6ab	10336.5ab	3076.0	2477.0	2776.56ab
34% Barley									
66% Urem	47343.3a	35146.0a	41244.7a	15570.0ab	12840.0a	14205.0a	2825.0	2445.3	2635.20ab
34% Barley									
66% Common vetch line 845	46666.7a	32777.7a	39722.2a	15336.3ab	10172.7ab	12754.5a	3356.0	2487.7	2921.80ab
34% Barley									
66% Ege Beyazi	45208.7ab	39166.7a	42187.7a	15276.0ab	10608.3ab	12942.2a	3343.7	2458.0	2900.80ab
34% Barley									
66% Efes-79	46525.3a	40277.7a	43401.5a	14592.3abc	11245.0ab	12918.7a	3662.3	2130.7	2896.50ab
34% Barley									
66% Menemen-79	45138.7ab	40077.7a	42608.2a	15385.7ab	11698.0a	13541.8a	3617.0	2105.7	2861.30ab
34% Barley									
66% Grasspea line 455	44305.7ab	31111.0a	37708.3a	18767.7a	10104.0ab	14435.8a	3842.7	2706.0	3274.30a
34% Barley									
66% Grasspea line 463	33194.3ab	30555.7a	31875.0ab	13563.0abc	9337.0ab	11450.0ab	3639.7	2244.7	2942.20ab
34% Barley									
66% Grasspea line 38	35625.0ab	32500.0a	34062.5ab	14024.0abc	11051.3ab	12537.7a	3882.0	2639.0	3260.50a
Mean	40811.0a^{+}	33092.0b	36951.5	14198.0a^{+}	10304.0b	12251.0	3369.0a^{+}	2351.0b	2860.00
LSD	13274.3	10085.3	10789.7	5858.3	4566.5	4048.9	NS	NS	901.50

Table 3: Legume ratio in dry matter (%) and barley ratio in dry matter (%) at Tokat in 2002 and 2003. Karaelci and Urem-79 cultivars: Common vetch, Ege Beyazi cultivar: Hungarian vetch, Efes-79 and Menemen-79 cultivars: Hairy vetch

	Barley ratio in dry matter (%)			Legume ratio in dry matter (%)		
Mixture sowings	2002	2003	Mean	2002	2003	Mean
100% Barley	-	-	-	-	-	-
34% Barley						
66% Karaelci	93.10	95.37ab*	94.23ab*	6.90	4.63ab*	5.77ab*
34% Barley						
66% Urem	93.25	98.09a	95.67a	6.75	1.91b	4.33b
34% Barley						
66% Common vetch line 845	92.68	95.89ab	94.29ab	7.32	4.11ab	5.72ab
34% Barley						
66% Ege Beyazi	93.24	92.68b	92.96ab	6.76	7.32a	7.04ab
34% Barley						
66% Efes-79	93.79	94.18ab	93.99ab	6.21	5.82ab	6.01ab
34% Barley						
66% Menemen-79	92.61	91.67b	92.14b	7.39	8.33a	7.86a
34% Barley						
66% Grasspea line 455	93.30	95.04ab	94.17ab	6.70	4.96ab	5.83ab
34% Barley						
66% Grasspea line 463	90.20	94.16ab	92.18b	9.80	5.84ab	7.82a
34% Barley						
66% Grasspea line 38	94.69	95.21ab	94.95ab	5.31	4.79ab	5.05ab
Mean	92.98	94.70	93.84	7.02	5.30	6.16
LSD	NS	4.29	2.95	NS	4.29	2.95

Barley ratio in dry matter: Barley ratio in dry matter of the mixtures was not significant in the first year but significant at 5% level of probability in the first year (Table 3). Barley ratios in dry matter varied from 90.20 to 94.69% in the first year and from 91.67 to 98.09% in the second year (Table 3). Two year results indicated that 34% barley and 66% Urem-79 mixture produced the highest barley ratio in dry matter (95.67%), whereas, the mixture of 34% barley and 66% Menemen-79 had the lowest barley ratio in dry matter (92.14%) (Table 3). Based on barley ratios in the mixture, much higher barley ratios than original designed mixtures were obtained in harvest[19]. This is because, cereals suppresses legumes in spring due to their high tillering and growth characteristics.

Legume ratio in dry matter: Differences of legume ratio in dry matter of the mixtures was not significant in the first year but significant at 5% level of probability in the second year (Table 3). In 2002, legume ratios in dry matter

ranged from 5.31 to 7.39%. In 2003, the highest legume ratio in dry matter (8.33%) was obtained from the 34% barley and 66% Menemen-79 mixture while the lowest ratio (1.91%) was obtained from the mixture of 34% barley and 66% Urem-79 (Table 3). The mean legume ratio in dry matter varied from the mixture of 4.33% for 34% barley and 66% Urem-79 to 7.86% for 34% barley and 66% Menemen-79 mixture (Table 3). These findings have been found lower than findings of Altin and Ucan[20]. These differences might be resultid by ecological factors and the cultivars in the experiment. On the other hand, based on legume ratios in the mixture, much lower legume ratios than original designed mixtures were obtained in harvest. Similar findings have been cited by some other researchers[19,20,21].

Barley is a potentially promising crop component in the some legume-cereal mixtures for forage and hay production during winter period under rainfed conditions. Moreover, 34% barley and 66% grasspea line 455 mixture produced the highest dry matter (14435.5 kg ha^{-1}) and total seed yileds (3274.3 kg ha^{-1}). The highest green forage yield (43401.5 kg ha^{-1}) was obtained from the mixture including 34% barley and 66% Efes-79 mixture. Thirty four percent barley and 66% Urem-79 mixture produced the highest barley ratio in dry matter (95.67%). The highest legume ratio in dry matter (7.86%) was obtained from 34% barley and 66% Menemen-79 mixture. In result, the mixtures of 34% barley and 66% grasspea line 455 and 34% barley and 66% Efes-79 are recommended to obtain higher dry matter, total seed and green forage yields.

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