Turkish Journal of FIELD CROPS

Turkish Journal of
Field Crops
2014, 19(1), 59-65

YIELD AND QUALITY TRAITS OF SOME PERENNIAL FORAGES AS BOTH SOLE CROPS AND INTERCROPPING MIXTURES UNDER IRRIGATED CONDITIONS

Mehmet Salih SAYAR[1], Yavuz HAN[2], Halil YOLCU[3], Hatice Yücel[4]*

[1]Crop and Animal Production Department, Bismil Vocational Training School,
Dicle University, Bismil, Diyarbakir, TURKEY
[2]GAP International Agricultural Research and Training Center, Diyarbakir, TURKEY
[3]Kelkit Aydın Doğan Vocational Training School, Gumushane University, Kelkit, Gumushane, TURKEY
[4]Eastern Mediterranean Agricultural Research Institute, Dogankent, Adana, TURKEY
** Corresponding author: msalihsayar@hotmail.com*

Received: 24.02.2014

ABSTRACT

A field study was conducted to evaluate the yield and quality traits of sole lucerne (L), sole bromegrass (B), sole tall fescue (T), sole orchardgrass (O), sole ryegrass (R), and lucerne + bromegrass + tall fescue (L+B+T) and lucerne + bromegrass + tall fescue + orchardgrass + ryegrass (L+B+T+O+R) intercropping mixtures at the GAP International Agricultural Research and Training Centre under the irrigated conditions during 2009, 2010, and 2011 in the Southeastern Turkey. Dry matter yield (DMY), crude protein content (CPC), crude protein yield (CPY), acid detergent fiber (ADF), neutral detergent fiber (NDF), dry digestible matter (DDM), dry matter intake (DMI), total digestible nutrients (TDN), and relative feed value (RFV) were determined in this study. The L+B+T intercropping mixture and sole lucerne provided higher yields than the other crops tested. Sole lucerne had higher protein and quality contents than the other sole perennial forages and intercropping mixtures. The L+B+T intercropping mixture had a higher yield and quality than the other sole perennial forages and intercropping mixtures, with the exception of sole lucerne.

Keywords: ADF, crude protein, dry matter yield, intercropping mixture, relative feed value

INTRODUCTION

The Southeastern Anatolian Region comprises nine provinces and is one of the driest region of Turkey. Dry farming systems have been practiced in most of the agricultural areas of this region until last decades (Bengisu, 2011). The Southeastern Anatolian Project (GAP) was initiated in 1989 in this region to increase the area of irrigated agricultural land and electricity production (Sahin and Tasligil, 2013). A large number of hydroelectric power plants have been completed, and irrigation studies are progressing in this region (Sahin and Tasligil, 2013). Large areas of agricultural land recently have started to be irrigated in this area as a result of project work (Bengisu, 2011).

The region has significant potential in terms of the presence of livestock, but the yield of these animals is not at the desired level (Sakarya et al., 2008). There are several reasons for this situation, but one of the most important is the insufficient production of quality roughage (Sakarya et al., 2008). Total roughage that is produced in forage crops cultivated areas and pasture-rangelands can meet only 33% of the available roughage requirements in this region (Sayar et al., 2010). Farmers have a significant opportunity to meet their roughage requirements due to the increased productivity resulting from the improved irrigation. They have started to produce forage under irrigated conditions in areas where irrigation works have been completed through the project. However, the new irrigation conditions have necessitated changes to established crop patterns for successful forage production. There is limited knowledge regarding which forage crop species and mixtures of crops can be grown under the new irrigated conditions. The determination of which new perennial forage species and mixtures of crops are most convenient is important for improving forage production.

It is hypothesized that lucerne, bromegrass, tall fescue, orchardgrass, ryegrass and mixtures of these crops can be successfully cultivated for yield and quality under the new irrigated conditions. Therefore, the aim of this study was to evaluate the yield and some quality traits of sole lucerne, sole bromegrass, sole tall fescue, sole orchardgrass, sole ryegrass, and lucerne + bromegrass + tall fescue (L+B+T) and lucerne + bromegrass + tall fescue + orchardgrass + ryegrass (L+B+T+O+R) intercropping mixtures under the irrigated conditions.

MATERIALS AND METHODS

Field experiment and growth conditions

This study was conducted for 3 consecutive years (2009, 2010, and 2011) at an experimental site in the GAP International Agricultural Research and Training Centre (GAP IARTC), Diyarbakır, Turkey (37º56'41.0"N, 40º15'16.8"E and altitude 607 m). Sole lucerne, sole bromegrass, sole tall fescue, sole orchardgrass, sole ryegrass, and lucerne + bromegrass + tall fescue (L+B+T) and lucerne + bromegrass + tall fescue, + orchardgrass + ryegrass (L+B+T+O+R) intercropping mixtures were sown on 20 March 2009 under irrigated conditions. The experimental design was a Randomized Complete Block with three replications. The common and scientific, cultivar names and the seeding rates of the sole forage crops and their mixtures are given in Table 1. Some characteristic traits of the experimental field soil are presented in Table 2. The research plots consisted of six rows of 6-m length, and the rows were spaced 30 cm apart. Nitrogen and phosphorus fertilizers were applied to the soil at a rate of 60 kg ha^{-1} before seeding.

Table 1. Common, scientific and cultivar names and seeding rates of the sole forage crops and their mixtures

Common name	Scientific name	Cultivar name	(kg ha^{-1})
Lucerne (L)	Medicago sativa L.	Elçi	30 kg
Bromegrass (B)	Bromus inermis Leys	Population	40 kg
Tall Fescue (T)	Festuca arundinacea Schreb.	Shelby	40 kg
Orchardgrass (O)	Dactylis glomerata L	Amba	30 kg
Ryegrass (R)	Lolium perenne L	XLT	40 kg
20% L +40% B +40% T			6 kg + 16 kg + 16 kg
25% L + %20B + 25%T + 15%O + 15%R			7.5 kg + 10 kg + 8 kg + 4.5 kg + 6 kg

Table 2. Some chemical and physical properties of the research soil.

Depth	Color	pH	Saturation (%)	Organic Matter (%)	CaCo3 (%)	P_2O_5 (kg ha^{-1})	K_20 (kg ha^{-1})	Structure
0-30 cm	red brown	7.8	62	1.4	13.7	28	480	Clay-loamy

All plots were irrigated once a week with sprinkler irrigation. Climatic data for the experimental location are shown in Table 3. Lucerne and mixtures including lucerne were harvested at 10% of the flowering stage. Other forage crops were harvested at the beginning of their flowerings. All plots were mowed four times in 2009 and six times in 2010 and 2011.

Table 3. Climatic data of the location in 2009, 2010, 2011 and long-term average (1975-2012) at Diyarbakır location, Turkey

	J	F	M	A	M	J	J	A	S	O	N	D	
Years	**Total Precipitation (mm) (Monthly)**												**Mean**
2009	12.4	70.0	63.9	43.9	9.1	25.8	1.6	0.0	25.2	62.4	55.6	87.2	457.1
2010	113.4	40.2	68.7	22.4	31.6	11.2	0.0	0.0	0.4	63.0	0.0	48.0	398.9
2011	40.0	49.9	46.6	209.0	80.1	13.6	0.6	0.0	9.2	11.8	73.0	40.2	574.0
1975-2012	62.8	67.8	67.3	67.7	39.6	9.0	0.4	0.4	4.3	32.1	51.1	67.4	469.9
	Mean air temperature (°C) (Monthly)												**Total**
2009	1.4	5.6	7.9	11.8	18.2	25.9	29.5	28.6	22.9	18.5	9.8	7.1	15.6
2010	5.4	6.6	11.1	14.2	20.4	27.2	32.3	32.0	27.0	18.1	11.1	6.5	17.7
2011	3.5	4.7	9.0	13.0	17.7	25.5	31.4	30.7	25.0	16.4	6.4	2.3	15.5
1975-2012	1.6	3.6	8.6	13.8	19.2	26.3	31.2	30.3	24.7	17.1	9.0	3.7	15.8
	Mean relative humidity (%) (Monthly)												**Mean**
2009	73.3	82.5	73.8	71.3	51.8	32.2	26.1	19.8	33.0	42.0	83.5	80.9	55.9
2010	80.9	79.9	66.6	60.4	49.3	29.1	19.6	17.5	27.4	56.0	41.1	68.9	49.7
2011	73.4	69.5	56.4	75.7	67.6	38.0	22.5	21.7	30.2	41.6	58.8	73.9	52.4
1975-2012	75.1	70.8	65.5	64.4	56.4	37.4	28.1	27.7	33.5	51.2	66.4	74.7	54.3

Plant and soil analysis

Dry matter yields were determined after green samples (0.5-kg biomass from each plot) were oven-dried at 70°C for 48 h and then ground to pass through a 1-mm sieve for the analysis of crude protein. The Kjeldahl method was used to determine the total N and the crude protein content of both sole forages and mixtures were determined as 6.25 × N (AOAC, 1995). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) analyses were undertaken according to ANKOM (1997). Dry digestible matter (DDM), dry matter intake (DMI), total digestible nutrients (TDN), and relative feed value (RFV) were calculated according to the equations of Schroeder (1994), as follows:

$$DDM\% = 88.9 - (0.779 \times ADF\%)$$

$$DMI\% = 120 / NDF$$

$$TDN\% = 96.35 - (ADF\% \times 1.15)$$

$$RFV = (DDM\% \times DMI\%) / 1.29$$

Also quality classes of the forages were determined according to Lacefield (1988).

Statistical analysis

All statistical analyses of data were performed using the JMP 5.0.1 statistical software package (SAS Institute, 2002), and the differences between means were compared using a least significant difference (LSD) test at the 0.05 probability level (Steel and Torrie 1980).

RESULTS AND DISCUSSION

The annual effects on dry matter yield (DMY), crude protein content (CPC), crude protein yield (CPY), ADF, NDF, DDM, DMI, TDN, and RFV were expected to be important and therefore, the results were expressed by year and averaged over the 3 years of the study.

Dry matter yield

The highest dry matter yield in 2009 was found in sole lucerne (17.19 t ha^{-1}) (Table 4). Sole lucerne (30.21 t ha^{-1}), L+B+T (28.88 t ha^{-1}) and the L+B+T+O+R intercropping mixture (26.71 t ha^{-1}) had higher dry matter yields in 2010. In 2011, the highest dry matter yield was achieved in the L+B+T intercropping mixture (32.21 t ha^{-1}) and the L+B+T+O+R intercropping mixture (29.09 t ha^{-1}), this followed by sole lucerne (27.52 t ha^{-1}). The L+B+T intercropping mixture and sole lucerne had higher dry matter yields (24.99 t ha^{-1} and 24.97 t ha^{-1}, respectively) than those of the other crops, based on the mean for the 3 years 2009, 2010, and 2011 (Table 4). Similarly, Kir and et al. (2010) reported that dry matter yields of sole lucerne changed from 8.75 t ha^{-1} to 30.05 t ha^{-1} among the means of seven years. Also, Koc et al. (2004) reported that there were differences between sole tall fescue and a tall fescue + lucerne intercropping mixture in terms of the dry matter yield. Balabanli et al. (2010) reported differences in the dry matter yield amongst various intercropping mixtures. In addition, Karadag and Buyukburc (2004) and Yolcu et al. (2009a) determined differences in the dry matter yield between sole and intercropping mixtures of forages.

Table 4. Dry matter yield, crude protein content and crude protein yield of some perennial forages as sole crops and intercropping mixtures

Treatments	Dry matter yield (t ha^{-1})				Crude protein content (%)				Crude protein yield (t ha^{-1})			
	2009	2010	2011	Mean	2009	2010	2011	Mean	2009	2010	2011	Mean
Lucerne	17.19 a	30.21 a	27.52 b	24.97 a	21.5 a	19.3 a	20.0 a	20.3 a	3.70 a	5.84 a	5.50 a-b	5.01 a
Bromegrass	4.15 e	8.82 b	6.29 c-d	6.42 c	17.4 b	13.8 d	14.7 c-d	15.3 c	0.72 e	1.21 d-e	0.92 c	0.95 d-e
Tall Fescue	3.90 e	6.27 b	7.88 c-d	6.02 c	14.0 c	11.6 e	13.3 d	13.0 d	0.55 e	0.73 e	1.04 c	0.77 e
Orchardgrass	3.60 e	9.57 b	4.56 d	5.91 c	16.0 b-c	14.4 c-d	15.8 c	15.4 c	0.58 e	1.38 d	0.72 c	0.89 e
Ryegrass	7.02 d	7.88 b	8.51 c	7.81 c	16.5 b	15.1 b-d	15.7 c	15.7 c	1.16 d	1.16 d-e	1.34 c	1.22 d
L + B + T	13.90 b	28.88 a	32.21 a	24.99 a	20.0 a	16.7 b	18.2 b	18.3 b	2.78 b	4.80 b	5.86 a	4.48 b
L + B + T + O + R	11.29 c	26.71 a	29.09 a-b	22.36 b	19.9 a	15.8 b-c	17.4 b	17.7 b	2.25 c	4.18 c	5.06 b	3.83 c
Mean	8.72 b	16.90 a	16.58 a	14.07	17.9 a	15.2 c	16.4 b	16.5	1.68 b	2.76 a	2.92 a	2.45
CV (%)	9.88	12.4	13.1	8.0	7.3	6.0	5.4	3.7	11.7	10.5	15.2	6.7
LSD (0.05)	1.53**	3.73**	3.87**	2.00**	2.3**	1.7**	1.6**	1.1**	0.35**	0.52**	0.79**	0.29**

Crude protein content and crude protein yield

Crude protein content of sole lucerne (21.5%), L+B+T (20.0%) and L+B+T+O+R (19.9%) intercropping mixtures were higher than the four sole grasses species in 2009 (Table 4). However, In both 2010 and 2011, the highest crude protein content was found only in sole lucerne (19.3% and 20.0%, respectively). In both years the L+B+T intercropping mixture had the next highest crude protein content (16.7% in 2010 and 18.2% in 2011). Accordingly; the greatest crude protein content was found in sole lucerne (20.3%) followed by the L+B+T (18.3%) and L+B+T+O+R (17.7%) intercropping mixtures, based on the mean for the 3 years 2009, 2010, and 2011 (Table 4). Findings determined in this study related to crude protein content of sole perennial forage species complied with Serin et al. (1998) (15.7-19.7%) and Albayrak et al. (2011) (18.9%) in sole lucerne, Meyer et al. (1977) in bromegrass (8-19%), Weller and Cooper, (2008) in ryegrass (12.2-17.3%), Sahin et al. (2010) in orchardgrass (7.82%-15.1%). Furthermore; many researchers reported that crude protein content of sole tall fescue forage ranged between 7.7% and 16.8% (Sheaffer and Marten, 1986; Evers et al., 1993; Macadam et al., 1997, Kusvuran and Tansı, 2003; Cınar, 2012). In both 2009 and 2010, sole lucerne had the greatest crude protein yield (3.70 t ha^{-1} and 5.84 t ha^{-1}, respectively) (Table 4), followed by the L+B+T intercropping mixture (2.78 in 2009 and 4.80 t ha^{-1} and 2010). The highest crude protein yield in 2011 was found in the L+B+T intercropping mixture (5.86 t ha^{-1}) and sole lucerne (5.50 t ha^{-1}) followed by the L+B+T+O+R intercropping mixture (5.06 t ha^{-1}). Accordingly; sole lucerne had the highest crude protein yield (5.01 t ha^{-1}) based on the mean for the 3 years of 2009, 2010, and 2011 (Table 4), followed by the L+B+T intercropping mixture (4.48 t ha^{-1}). Similar differences in crude protein content and yield were reported by Yolcu et al. (2009a) between various sole forage crops and intercropping mixtures. In addition, Yucel and Avcı (2009) reported differences in the crude protein content and yield between sole forages and intercropping mixtures. Additionally; in consistent with our research findings many researchers reported that not only sole lucerne sowing had more crude protein content than grasses sowings, but also legume + grass sowings had more crude protein content than sole grasses sowings (Barnett and Posler, 1983; Spandl and Hesterman, 1997; Serin et al., 1998; Albayrak and Ekiz, 2005, Albayrak et al., 2011).

Acid detergent fiber (ADF) and neutral detergent fiber (NDF)

Acid detergent fiber (ADF) and neutral detergent fiber (NDF) concentrations are important quality parameters of forages (Schroeder, 1994; Caballero et al., 1995; Henning et al., 1996; Assefa and Ledin, 2001; Albayrak et al., 2011). Although ADF refers to the cell wall portions of a forage that are made up of cellulose and lignin, NDF refers to the total cell wall, which is comprised of the ADF fraction plus hemicellulose. As the ADF and NDF percentages increase, quality and digestibility of a forage usually decrease (Lacefield, 1988; Schroeder, 1994; Henning et al., 1996; Joachim and Jung, 1997; Albayrak et al., 2011).

In the study; sole lucerne had the lowest ADF content in 2009 and 2011 (28.3 and 28.1%, respectively). However, there weren't found significant differences among lucerne (29.8%), ryegrass (32.7%), L + B + T (32.9%) and L + B + T + O + R (32.6%) in terms of ADF content in 2010. And ADF contents of the treatments were found lower than the other species (Table 5). Accordingly; the lowest ADF content was found in sole lucerne (28.7%) followed by the L+B+T (32.1%) and L+B+T+O+R (32.4%) intercropping mixtures, based on the mean for the 3 years 2009, 2010, and 2011 (Table 5). On the other hand; sole lucerne had the lowest NDF content in 2009 and 2010 (35.0 and 44.3%, respectively), but there weren't found statistically significant differences among the treatments in terms of NDF contents in 2011. And, the lowest NDF content was found in sole lucerne (41.5%) followed by the L+B+T+O+R (45.1 %) and L+B+T (45.2 %) intercropping mixtures, based on the mean for the 3 years 2009, 2010, and 2011 (Table 5). Similarly; many researchers reported that differences in the ADF and NDF among various sole sowings and intercropping mixtures were found as highly significant (Yucel and Avcı 2009; Yolcu et al., 2009a; Yolcu et al., 2009b, Balabanlı et al., 2010; Albayrak et al., 2011).

Table 5. Acid detergent fiber and neutral detergent fiber content of some perennial forages as sole crops and intercropping mixtures

Treatments	Acid detergent fiber (ADF) (%)				Neutral detergent fiber (NDF) (%)			
	2009	2010	2011	Mean	2009	2010	2011	Mean
Lucerne	28.3 e	29.8 c	28.1 d	28.7 e	35.0 f	44.3 d	45.3	41.5 d
Bromegrass	34.0 b-c	38.0 a-b	34.7 a-c	35.6 b-c	45.5 c	52.6 b-c	49.2	49.1 b
Tall Fescue	37.3 a	40.0 a	37.1 a-b	38.1 a	51.9 a	58.3 a	55.8	55.3 a
Orchardgrass	34.8 b	36.4 b	37.8 a	36.3 a-b	47.8 b	53.6 b	46.9	49.4 b
Ryegrass	32.0 c-d	32.7 c	37.1 a-b	33.9 c-d	46.4 b-c	48.6 c-d	50.0	48.3 b
L + B + T	31.7 d	32.9 c	31.6 c-d	32.1 d	39.1 e	49.7 b-c	46.9	45.2 c
L + B + T + O + R	32.6 c-d	31.7 c	32.9 b-c	32.4 d	41.8 d	49.3 b-c	44.3	45.1 c
Mean	33.0 b	34.5 a	34.2 ab	33.9	43.9 b	50.9 a	48.3 c	47.7
CV (%)	3.6	5.6	7.6	4.0	2.5	4.9	8.7	3.2
LSD (0.05)	2.1**	3.5**	4.6**	2.4**	1.9**	4.5**	ns	2.8**

Dry digestible matter (DDM) and dry matter intake (DMI)

There is inverse relation between ADF percent of a forage and its DDM value, likewise; similar relation has between NDF percent of a forage and its DMI value. Namely, as ADF percent of a forage increase, its dry matter digestibility by livestock decreases, similarly, as NDF percent of a forage increases, intake amount of the forage by livestock decreases (Lacefield, 1988; Schroder, 1994; Henning et al 1996; Jeranyama and Garcia, 2004). In the study; sole lucerne had the highest DDM content in 2009 (66.9%), and DDM contents of sole lucerne, sole ryegrass, L + B + T and L + B + T + O + R intercropping mixtures were higher than DDM contents of sole bromegrass, sole tall fescue and sole orchardgrass in 2010. Additionally; DDM contents of lucerne and L + B + T were higher than the other treatments in 2011. According to averages of the three years, the highest DDM content was found in sole lucerne (66.5 %), and it was followed by the L+B+T (63.9%) and L+T+B+O+R (63.7%) intercropping mixtures (Table 6). Similarly; the greatest DMI contents were found in sole lucerne (3.4 and 2.7%, respectively) in 2009 and 2010 (Table 6). Sole lucerne had the highest DMI content (2.9%), followed by the L+B+T (2.7%) and L+B+T+O+R (2.7%) intercropping mixtures, based on the mean for the 3 years 2009, 2010, and 2011 (Table 6). Yucel and Avcı (2009) also reported differences in DDM and DMI among sole vetch, triticale, and mixtures containing these crops. Similar differences in DDM and DMI were reported among different forage crops and intercropping mixtures by Yolcu et al., (2009a).

Table 6. Digestible dry matter and dry matter intake of some perennial forages as sole crops and intercropping mixtures

Treatments	Digestible dry matter (DDM)				Dry matter intake (DMI)			
	2009	2010	2011	Mean	2009	2010	2011	Mean
Lucerne	66.9 a	65.7 a	67.0 a	66.5 a	3.43 a	2.72 a	2.66	2.94 a
Bromegrass	62.4 c-d	59.3 b-c	61.9 b-d	61.2 c-d	2.64 d	2.28 b-c	2.44	2.45 c
Tall Fescue	59.8 e	57.8 c	60.0 c-d	59.2 e	2.31 f	2.06 d	2.16	2.18 d
Orchardgrass	61.8 d	60.6 b	59.4 d	60.6 d-e	2.51 e	2.25 c-d	2.56	2.44 c
Ryegrass	64.0 b-c	63.4 a	60.0 c-d	62.5 b-c	2.59 d-e	2.47 b	2.41	2.49 c
L + B + T	64.2 b	63.3 a	64.3 a-b	63.9 b	3.07 b	2.42 b-c	2.58	2.69 b
L + B + T + O + R	63.5 b-c	64.2 a	63.3 b-c	63.7 b	2.87 c	2.43 b-c	2.72	2.68 b
Mean	63.2 a	62.0 b	62.3 ab	62.5	2.78 a	2.38 c	2.51 b	2.55
CV (%)	1.4	2.4	3.2	1.7	2.16	4.64	8.40	2.74
LSD (0.05)	1.6**	2.7**	3.6**	1.9**	0.11**	0.20**	ns	0.13**

Total digestible nutrients (TDN)

The TDN refers to available the nutrients for livestock in forages, and variation among TDN values depend on the ADF concentration of the forages and, as percent of ADF increases, TDN declines (Albayrak et al. 2011). According to Henning et al. (1996) 61.2% TDN value is enough for most of the production stages of livestock. In the study; the highest TDN content was found in sole lucerne in 2009, 2010, and 2011 (63.8, 62.1 and 64.1%, respectively) (Table 7). Sole lucerne had the greatest TDN content (63.3%) followed by the L+B+T (59.5%) and L+B+T+O+R (59.1%) intercropping mixtures, based on the mean for the 3 years 2009, 2010, and 2011 (Table 7). Similarly; Albayrak et al. (2011) reported differences in the TDN values among sole perennial and intercropping perennial forages. Also, they cited that the highest the TDN value was obtained from sole lucerne sowing.

Table 7. Total digestible nutrients and relative feed value of some perennial forages as sole crops and intercropping mixtures

Treatments	Total digestible nutrients (TDN)				Relative feed value (RFV)			
	2009	2010	2011	Mean	2009	2010	2011	Mean
Lucerne	63.8 a	62.1 a	64.1 a	63.3 a	177.6 a	138.6 a	138.3 a	151.4 a
Bromegrass	57.2 c-d	52.6 b-c	56.5 b-d	55.4 c-d	127.7 d	104.8 c	117.2 b-d	116.4 c
Tall Fescue	53.4 e	50.4 c	53.7 c-d	52.5 e	107.4 f	92.5 d	100.3 d	100.0 d
Orchardgrass	56.3 d	54.5 b	52.8 d	54.6 d-e	120.3 e	105.5 c	118.2 a-d	114.7 c
Ryegrass	59.6 b-c	58.7 a	53.7 c-d	57.3 b-c	128.4 d	121.5 b	112.2 c-d	120.6 c
L + B + T	59.8 b	58.6 a	60.0 a-b	59.5 b	152.7 b	118.5 b	128.8 a-c	133.2 b
L + B + T + O + R	58.9 b-c	59.9 a	58.6 b-c	59.1 b	141.5 c	121.1 b	133.5 a-b	132.1 b
Mean	58.4 a	56.7 b	57.1 ab	57.4	136.5 a	114.6 c	121.2 b	124.1
CV (%)	2.3	3.9	5.2	2.7	2.2	5.2	9.5	3.2
LSD (0.05)	2.4**	4.0**	5.3**	2.7**	5.4**	10.6**	20.4*	7.1**

Relative feed value (RFV) and the forages quality classes

RFV is an index combining the important nutritional components of intake and digestibility of forages. Although the index has no units, comparisons forage quality of grasses, legumes, and intercropping mixtures can be made by using the index. A forage with 41% ADF and %43 NDF has 100 RFV value. The other forages can be evaluated comparison with this value. As ADF and NDF percents decrease, the RFV value increases (Schroder, 1994). In the study; the highest RFV was found in sole lucerne (151.4) followed by the L+B+T (133.2 %) and L+B+T+O+R (132.1 %) intercropping mixtures, based on the mean for the 3 years 2009, 2010, and 2011 (Table 7). Similarly; Albayrak et al. (2011) and Yolcu et al. (2009a) reported that there were differences in the RFV among different sole sowings and intercropping mixtures.

By taking into consideration the RFV value of forages, Lacefield (1988) devoted the forages to quality classes. In this classification; if a forage RFV value is bigger than 151, it is accepted as the best quality forage. If forage the RFV value is between 151-125, 124-103 and 102-87, it is accepted as first, second and third quality classes respectively (Lacefield, 1988). In our study; based on the mean for the 3 years RFV values; although sole lucerne forage took place in the best (prime) quality class, the forages obtained from L + B + T and L + B + T + O + R intercropping mixtures took place in the first quality class. On the other hand; except for sole tall fescue forage, third quality class, the other sole grasses species forages took place in the second quality class.

CONCLUSION

Substantial changes in the established crop patterns would be required for successful forage production when switching from dry farming to the irrigated agriculture. The determination of the most convenient new perennial forage species and mixtures of the crops is important for improving forage production.

The results of this research revealed that the L+B+T intercropping mixture and sole lucerne had the highest yields. We suggest that sole lucerne should be cultivated primarily under the irrigated conditions, due to its greater protein and quality components than the L+B+T intercropping mixture. Legume and grass intercropping mixtures produce balanced feeds in terms of protein, carbohydrate, and other quality components. Therefore, if intercropping mixtures are planted, an L+B+T intercropping mixture will be preferable due to its higher yield and quality, and easier establishment and management as compared to the L+B+T+O+R intercropping mixture.

ACKNOWLEDGEMENT

The study was supported financially by the General Directorate of Agricultural Research and Policy (TAGEM/TA/07/11/02/001), We are also grateful to the GAP International Agricultural Research and Training Center, Diyarbakır, for their assistance with field trials, and the Eastern Mediterranean Agricultural Research Institute, Adana, Turkey, for their assistance in terms of the dry matter quality analyses.

LITERATURE CITED

Albayrak, S., M. Turk, O. Yuksel, M. Yılmaz. 2011. Forage yield and the quality of perennial legume- grass mixtures under rainfed conditions. Notulae Botanicae Horti Agrobotanica Cluj-Napoca, 39:114-118

Albayrak, S., H. Ekiz. 2005. An investigation on the establishment of artificial pasture under Ankara’s ecological conditions. Turk. J. Agric. For. 29:69-74.

Ankom Technology Corporation, 1997. Operator’s manual. Ankom 200/220 Fiber Analyzer. Ankom Thec. Corp.

AOAC. 1995. Offical Methods of Analysis. Assoc. of Official Analytical Chemists, Arlington, VA. Ankom Technology Corporation, 1997. Operator’s manual. Ankom 200/220 Fiber Analyzer. Ankom Thec. Corp.

Assefa, G. and I. Ledin. 2001. Effect of variety, soil type and fertilizer on the establishment, growth, forage yield, quality and voluntary intake by cattle of oats and vetches cultivated in pure stand and mixtures. Animal Feed Science Technology, 92: 95-111.

Balabanli, C., S. Albayrak, M. Turk, O. Yuksel. 2010. A research on determination of hay yields and silage qualities of some vetch + cereal mixtures. Turk. J. Field Crops, 15: 204-209.

Barnett, F. and G.L. Posler. 1983. Performance of cool-season perennial grasses in pure stands and in mixtures with legumes. Agronomy Journal, 75(4):582-586.

Bengisu, G. 2011. Crop rotation systems for sustainable agriculture in the GAP Region. Alinteri, 20: 33-39.

Caballero AR, E.L. Goicoechea-Oicoechea, P.J. Hernaiz-Ernaiz. 1995. Forage yields and quality of common vetch and oat sown at varying seeding ratios and seeding rates of vetch. Field Crops Res. 41:135-140.

Cınar, S. 2012. determination of yield and quality characteristics of some cultivars and populations of tall fescue (*Festuca arundinaceae* Schreb.) in Cukurova Region. Journal of Agric. Fac. of Gaziosmanpasa Univ. 29 (1): 29–33

Evers, G.W., M. Gabrysch, and C.R. Tackett. 1993. Performance of Cool-Season Perennial Grasses on Poorly Drained Clay Soils. Forage Research in Texas, PR-5080, p. 6-9.

Henning, J.C., G.D. Lacefield, and D. Amaral-Phillips. 1996. Interpreting forage quality reports. Agron. Publ. ID-101., University of Kentucky, Lexington, KY.

Jeranyama, P. and A.D. Garcia. 2004. Understanding Relative Feed Value (RFV) and Relative Forage Qality (RFQ). http://agbiopubs. sdstate.edu/articles/ExEx8149.

Joachim H and G. Jung. 1997. Analysis of forage fiber and cell walls in ruminant nutrition. Journal of Nurtition, 127:810-813.

Karadag, Y., U. Buyukburc. 2004. Forage qualities, forage yields and seed yields of some legume–triticale mixtures under rainfed conditions, Acta Agriculturae Scandinavica, Section B - Soil & Plant Sci. 54: 140-148.

Kir, B., G. Demiroglu, R. Avcioglu, H. Soya. 2010. Effects of grazing on some yield and quality traits of a rotation pasture mixture under mediterranean. Turk. J. Field Crops, 2010, 15(2): 133-136.

Koc, A., A. Gokkus, M. Tan, B. Comaklı and Y. Serin 2004. Performance of tall fescue and lucerne-tall fescue mixtures in highlands of Turkey. New Zealand Journal of Agricultural Research, 47: 61-65.

Kusvuran, A. and V. Tansı. 2003. Determining effect of cutting frequency on some vegetative and generative characteristics of different grasses species in Cukurova conditions. Journal of Agric. Fac. of Cukurova University. 18 (1): 45-54.

Lacefield, G.D., 1988. Alfalfa Hay Quality Makes the Difference. University of Kentucky Department of Agronomy AGR-137, Lexington, KY.

Macadam, J.W., R.E. Whitesides, M.B. Winger and S. Buffer. 1997. Pasture Species for Grazing-Based Dairy Production Under Irrigation in the Intermountain West. Proceedings of the XVIII. International Grassland Congress, Canada, p. 99-100.

Meyer, D.W. J.F. Carter, F.R. and Vigil 1977. Bromegrass fertilization at six nitrogen rates: long and short term effects. North Dakota Farm. Res. 34: 13-17.

Sahin, E., M. Tosun, K. Haliloglu, M. Aydın. 2010. Agricultural and quality properties of oltu ecotypelines of wild orchardgrass (Dactylis glomerata L.). Journal of Agric. Fac. of Süleyman Demirel University, 5 (1):24-35, 2010

Sahin, G., N. Tasligil. 2013. The past the present and the future of Southeastern Anatolia Project (SAP). International Refereed Online Journal of Social Sciences. 36:1-26.

Sakarya, E., Y. Aral, E. Aydın. 2008. The significance of the Southeastern Anatolian Project and livestock in the development of Southeastern Anatolia Region. Vet Hekim Der Derg. 79 : 35-42.

SAS, Institute. 2002. JMP Statistics. Cary, NC, USA: SAS Institute, Inc. 707 p.

Sayar, M.S., A.E. Anlarsal, M. Basbag. 2010. Current situation, problems and solutions for cultivation of forage crops in the Southeastern Anatolian Region. J. Agric. Fac. HR.U., 14: 59-67.

Schroeder, J.W. 1994. Interpreting Forage Analysis. Extension Dairy Specialist (NDSU), AS-1080, North Dakota State University.

Serin, Y, A. Gokkuş, M. Tan, B. Çomaklı and A. Koç. 1998. Determination of suitable forage crop species and their mixturres of meadow establishment. Turk. J. Agric. For. 22:13-20.

Sheaffer, C.C. and G.C. Marten, 1986. effect of mefluidide on cool-season perennial grass forage yield and quality. Agronomy Journal, 78:75-79.

Spandl, E. and O.B. Hersterman, 1997. Forage quality and alfalfa characteristics in binary mixtures of alfalfa and bromegrass or timothy. Crop Sci. 37:1581-1585.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics: A Biometrical Approach. 2. ed. New York: McGraw-Hill Publ. Company.

Yucel, C. and M. Avci. 2009. Effect of different ratios of common vetch (*Vicia sativa* L.) – triticale (Triticosecale Whatt) mixtures on forage yields and quality in Cukurova plain in Turkey. Bulg. J. Agric. Sci., 15: 323-332.

Yolcu, H., M. Dasci and M. Tan, 2009a. Evaluation of annual legumes and barley as sole crops and intercrop in spring frost conditions for animal feeding I. Yield and Quality. J. Anim. Vet. Adv., 8: 1337-1342.

Yolcu, H., M. Polat and V. Aksakal. 2009b. Morphologic, yield and quality parameters of some annual forages as sole crops and intercropping mixtures in dry conditions for livestock. J. of Food, Agriculture & Environ. 7: 594-599.

Weller, R.F., A. Cooper. 2008 Seasonal changes in the crude protein concentration of mixed swards of white clover/perennial ryegrass grown without fertilizer N in an organic farming system in the United Kingdom. Grass and Forage Sci. 56: 92-95