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FORAGE POTENTIAL OF COWPEA (*Vigna unguiculata* L. WALP).

Ilknur AYAN[1], Hanife MUT[2], Ugur BASARAN[2], Zeki ACAR[1], Ozlem Onal ASCI[3]*

[1]*Department of Field Crops, Faculty of Agriculture, Ondokuz Mayıs University, Samsun, TURKEY.*
[2]*Department of Field Crops, Faculty of Agriculture, Bozok University, Yozgat, TURKEY.*
[3]*Department of Field Crops, Faculty of Agriculture, Ordu Universityt, Ordu, TURKEY.*
Corresponding author: hanife.mut@bozok.edu.tr

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ABSTRACT

Nine Cowpea (*Vigna unguiculata* L. Walp) genotypes were assessed for forage yield and quality features during 2005 and 2006 summer growing season at two locations (Samsun and Kavak) in Turkey. Experiments were established on May and arranged in a randomized complete block design with 3 replications in both years and locations. Although cowpea is not grown for forage purposes, their forage yield and quality are desirable in experiment conditions. Forage yield significantly (P<0.01) affected by genotype, year and location and ranged between 6.03 and 7.94 t ha^{-1} among genotypes over the years and locations. No differences were found in crude protein (CP) among cultivars and years, which ranged from 170.2 g kg^{-1} for cultivar Akkiz up to185.2 g kg^{-1} for genotypes G3, G4 over the years and locations. There were no significant differences among genotypes for ADF, NDF, Mg and P contents. P, Mg, Ca and K contents in all the genotypes were higher than animal needs in both locations. In general, cowpea genotypes had higher forage yield, CP and lower ADF and NDF at Samsun compare to Kavak location.

Key Words: Cowpea, forage yield, protein, ADF, NDF, mineral mater, Turkey

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) belonging *Fabaceae* is a substantial food and a valuable items of the conventional cropping systems in the drier region tropics of Asia, Africa and Central America (Mortimore et al., 1997). This precious tropical and subtropical legume is especially important for the semi-arid regions of the tropics for forage, green pods and grains (Adeyanju et al., 2007; Ali et al., 2004).

Although cowpea can be grown under dry condition, irrigation highly promotes its vegetative growth and results late maturity of seeds (Peksen, 2007) Cowpea produced highest forage yields in sandy loam soils with proper irrigation regime (Ali et al., 2004). Cowpea hay is a nutritious balanced fodder for animals (Singh et al., 2003) and have a great function in feeding animals during the dry season in West Africa (Tarawali et al., 2002). Cowpea can also intercropped with maize (Dahmardeh et al., 2009) and sorghum (Ahmad et al., 2007) for a higher yield and quality compare to sole cropping

The biggest technical constraint in livestock production in Turkey is forage deficiency especially during summer period when pasture vegetation is dry. So there is a need for new warm-season forages to fill forage gap in this period. In general, solutions to forage shortages during the summer months have included the use of perennial and annual warm-season species for pastures, hay, or silage. Despite having a significant potential regarding forage production, there are limited studies on cowpea to investigate its forage yield and quality in Turkey. Cowpea is grown only for human consumption and with production of 2149 tons grain and 19 967 tons fresh pod in Turkey (TUIK, 2011). Most of the previous studies were performed to evaluate dry seed or green pod (Gulumser et al., 1989; Peksen et al., 2002; Peksen, 2004; Peksen and Artık, 2004; Vural and Karasu, 2007; Basaran et al., 2011). Therefore our knowledge on the forage performance of cowpea is insufficient.

This study was conducted to determine forage yield and quality of different cowpea genotypes at two locations in Turkey.

MATERIALS AND METHODS

Two released varieties (Akkiz, Karagoz) and seven lines (G1,...,G7) of cowpea were studied for forage yield and related quality features during 2005 and 2006 summer growing season at two locations (Samsun and Kavak). Samsun (41°21'51"N, 36°11'27"E) is located near costal area at an altitude 196 m and, Kavak (41°03'14"N, 35°57'32"E) is located inner region at an altitude 575 m. In Samsun, years 2005 and 2006 annual rainfall was 788.1 and 714 mm, mean temperature was 15 ^{0}C and 14.5 ^{0}C, relative humidity was 75.4 % and 74.3 %, respectively. Both locations have approximately similar annual rainfall during vegetation period. However relative humidity and night temperature are lower in Kavak compare to Samsun. The soil texture of Samsun and Kavak locations were clay and silt respectively.

Experiments were arranged in a randomized complete block design with 3 replicates during two consecutive years. The experimental plots consisted of 4 rows, each 4 m in length with 50 cm row spacing in both locations. Experiments were established on May in both years and locations, with application of 50 kg ha^{-1} nitrogen. Experiments were irrigated two times; first was made the plants 15 to 20 cm, the second was made before the flowering. Weed control was made by hand when it was necessary. The plots were harvested at the first pod maturity stage. The two inner rows were harvested for forage by removing outer 50 cm of each row.

Forage samples taken from each plot were oven-dried at 60 ^{0}C and ground to pass through a 1 mm screen for chemical analysis. Crude protein, acid detergent fiber (ADF), neutral detergent fiber (NDF), K (Potassium), Mg (Magnesium), Ca (Calcium) and P (Phosphorus) contents of samples were determined by using near infrared reflectance spectroscopy (NIRS) 13-15. with software program coded IC-0904FE.

The data were subjected to analysis of variance (ANOVA) and, computation was performed by means of SPSS 10.0 V. (SPSS Inc., 1999). Means were separated using Least Significance Difference (LSD) test.

RESULTS AND DISCUSSION

Average performance of the nine cowpea genotypes regarding forage yield and quality over years and locations are shown in Table 1. Genotype (G), year (Y), location (L) and GxY, GxL, LxY interactions were significant ($P<0.05$, $P<0.01$) for many of the traits studied (Table 1). All the traits significantly affected by the location. Therefore the results were given separately for locations. The mean performances of the cowpea genotypes for the studied traits at each of the two locations in combined years are shown in Table 2 and 3.

Table 1. Forage yield, some quality characters and mineral content of cowpea genotypes over the mean.

Genotype	FY (t ha^{-1})	CP (g kg^{-1})	ADF (g kg^{-1})	NDF (g kg^{-1})	K (g kg^{-1})	Mg (g kg^{-1})	Ca (g kg^{-1})	P (g kg^{-1})
Karagoz	6.97	177.0	276.4	339.2	14.2	4.8	11.9	3.5
Akkiz	6.20	170.2	274.3	350.7	15.5	4.7	10.4	3.6
G1	6.89	176.0	284.7	350.3	15.1	4.8	11.4	3.7
G2	6.31	182.0	265.8	332.5	14.5	4.8	12.2	3.6
G3	6.03	185.2	274.0	330.8	15.6	4.6	10.9	3.6
G4	7.94	185.2	302.3	367.6	14.2	5.1	13.2	3.6
G5	6.22	179.3	289.0	348.5	13.6	5.0	12.9	3.6
G6	6.32	182.4	288.5	349.5	16.5	4.9	11.7	3.4
G7	6.40	177.7	289.3	354.4	13.0	5.0	11.9	3.5
LSD (0.05)[a]	0.39	9.96	21.92	24.84	2.14	0.35	1.15	0.24
Year (Y)	**	NS	**	**	**	**	**	**
Genotype (G)	**	NS	NS	NS	*	NS	**	NS
GxY	NS	**	**	**	**	NS	*	*
Location (L)	**	**	*	**	**	**	**	**
LxG	NS	**	NS	*	**	NS	**	NS
YxL	NS	**	NS	NS	**	**	**	**

FY: Forage yield, CP: Crude protein, ADF: Acid detergent fiber, NDF: Neutral detergent fiber, K: Potassium, Mg: Magnesium, Ca: Calcium, P: Phosphorus,
[a]Least significant difference at P=0.05. [NS]: Nonsignificant or significant at *$P<0.05$, **$P<0.01$

Table 2. Yield, crude protein, ADF and NDF contents of cowpea genotypes at each location over the years

Genotype	FY (t ha^{-1})		CP (g kg^{-1})		ADF (g kg^{-1})		NDF (g kg^{-1})	
	Samsun	**Kavak**	**Samsun**	**Kavak**	**Samsun**	**Kavak**	**Samsun**	**Kavak**
Karagoz	7.3	6.6	181.6	172.4	273.8	279.0	335.8	342.6
Akkiz	6.8	5.5	193.4	147.0	258.1	290.5	316.7	384.8
G1	7.4	6.3	181.1	170.8	264.6	302.8	326.8	378.8
G2	6.8	5.7	192.5	171.4	271.1	260.4	322.0	343.1
G3	6.5	5.5	184.3	186.1	243.8	304.2	290.8	370.8
G4	8.4	7.4	179.8	190.7	291.4	313.2	345.3	389.8
G5	6.5	5.8	187.7	170.9	282.6	295.4	331.0	365.9
G6	6.7	5.9	182.6	182.2	297.3	279.7	350.6	348.4
G7	6.9	5.8	191.6	163.7	287.7	290.9	353.5	354.4
Average	*7.07*	*6.11*	*186.1*	*172.8*	*274.5*	*290.7*	*330.3*	*363.8*
LSD (0.05)[a]	0.51	0.62	17.63	9.80	53.48	30.44	41.67	28.67
Year								
2005	6.98	5.98	180.2	177.9	258.1	266.1	315.0	338.8
2006	7.16	6.23	192.0	167.7	290.9	315.2	345.6	388.9

[a]Least significant difference at P = 0.05

Average forage yield (FY) significantly (P<0.01) affected by genotype, year and location and, it ranged between 6.03 and 7.94 t ha^{-1} among genotypes over the years and locations (Table 1).

However interactions (GxY, LxG and YxL) were not significant for FY (Table 1). Average FY was higher at Samsun location than Kavak in both years and, it was also higher in 2006 compare to 2005 at both locations. Genotype G4 had the highest FY both Samsun and Kavak with 8.4 t ha^{-1}, and 7.4 t ha^{-1}, respectively (Table 2).

Table 3. Mineral matter contents of cowpea genotypes at each location over the years

Genotype	K (g kg^{-1})		Mg (g kg^{-1})		Ca (g kg^{-1})		P (g kg^{-1})	
	Samsun	Kavak	Samsun	Kavak	Samsun	Kavak	Samsun	Kavak
Karagoz	16.3	12.0	4.5	5.10	10.0	13.9	3.3	3.6
Akkiz	17.5	13.4	4.5	4.76	10.9	9.9	3.3	3.8
G1	16.5	13.5	4.5	4.96	8.8	13.9	3.3	4.0
G2	16.5	12.5	4.6	5.03	10.6	13.7	3.3	3.8
G3	14.7	16.5	4.5	4.65	9.3	12.3	3.3	3.9
G4	14.7	13.6	4.9	5.20	11.7	14.6	3.2	3.9
G5	15.3	11.8	4.7	5.16	12.2	13.7	3.2	3.8
G6	14.9	18.0	4.8	4.91	10.7	12.7	3.3	3.5
G7	15.1	10.8	4.7	5.18	10.0	13.8	3.4	3.6
Average	*15.8*	*13.6*	*4.7*	*5.0*	*10.5*	*13.2*	*3.3*	*3.9*
LSD (0.05)[a]	*3.34*	*2.86*	*0.50*	*0.50*	*1.29*	*2.00*	*0.26*	*0.41*
Year								
2005	12.7	19.7	4.7	4.7	7.1	12.1	2.8	3.9
2006	18.8	7.7	4.6	5.3	13.8	14.3	3.8	3.9

[a]Least significant difference at P = 0.05.

No differences were found in crude protein (CP) among genotypes and years, which ranged from 170.2 g kg^{-1} for cultivar Akkiz up to185.2 g kg^{-1} for genotypes G3, G4 over the years and locations. However, location and all the interactions showed significant (p<0.01) effect on CP (Table 1). Greater average CP (186.1 g kg^{-1}) was determined at Samsun location than that was recorded at Kavak (172.8 g kg^{-1}). In addition, at Samsun location, average CP was different between years and was higher in year 2006 (192.0 g kg^{-1}) than in year 2005 (180.2 g kg^{-1}). High quality of forage has been notified as an important aspect of forage crop production. Cowpea fodder is a rich source of crude protein up to 184 g kg^{-1} (Khan et al., 2010) Furthermore, protein content of cowpe forage (220 g kg^{-1}) was higher compare to some legumes such as lablab (*Lablab prpureus*), mucuna (*Mucuna pruriens*) and grass species (*Sorghum sudanense*), however, it was the least consumed species by goats (Gwanzura et al., 2011)

There were no significant differences among genotypes for ADF and NDF contents (Table 1). According to combined years, average ADF and NDF contents among genotypes were higher at Kavak (290.7 g kg^{-1} and 363.8 g kg^{-1}) than Samsun (274.5 g kg^{-1} and 330.3 g $kg^{-1)}$, in addition, average ADF and NDF were higher in 2006 compare to 2005 at both locations (Table 2). The CP, ADF and NDF contents of the cowpea genotypes studied indicated that they came within the high quality forage group according to standards developed by the Hay Marketing Task Force of American Forage and Grassland Council (Rohweder et al., 1978).

The forage quality of cow pea genotypes and cultivars in terms of mineral matter (K, Mg, Ca and P) contents significantly (p<0.05, p<0.01) affected by year, location and YxL interaction. The effect of genotype was significant only for K and Ca contents (Table 1). Mineral mater contents of cowpea genotypes were higher at Kavak location over the years. But in contrast to other minerals, K content among cowpea genotypes was generally higher at Samsun location. The genotypes G2 (12.2 g kg^{-1}), G4 (13.2 g kg^{-1}) and G5 (12.9 g kg^{-1}) had the highest Ca content over the years and locations. The differences among genotypes for K content was significant and between 13.0 g kg^{-1} in G7 to 16.5 g kg^{-1} in G6 (Table 1).

Mg and P contents were not significantly affected by genotype, however, the effects of year and location was significant on these minerals (Table 1). In 2005, average Mg content was the same (4.7 g kg^{-1}) both locations, however, it was higher at Kavak than Samsun in 2006. Both years, mean P content at Kavak location was same (3.9 g kg^{-1}) and better than Samsun (Table 3). The mineral matter needs of gestating or lactating beef are 1.8 -4.4 g kg^{-1} for Ca, 0.4 - 1 g kg^{-1} for Mg, 6 – 8 g kg^{-1} for K and 1.8 – 3.9 g kg^{-1} for P (NRC, 1996; Tekeli and Ates, 2005). Tajeda et al. (1985) reported that forage should contain at the level of 2 g kg^{-1} Mg and at least 3 g kg^{-1} Ca for the ruminant. For this respect, P, Mg, Ca and K content of the forage in all the genotypes were higher than animal needs recommended by the pervious studies.

Higher forage yield, CP and lower ADF and NDF at Samsun suggesting that this location has better climatic conditions for cowpea growing for forage purpose. Cowpea best grows at day temperatures of 25-35 ^{0}C; night temperature should not be less than 15 ^{0}C, and its growth is retarded at altitudes above 700 m (Brink and Belay, 2006). Also, lower night temperature is a problem in cowpea growth (Ntare and Williams, 1993). Samsun located near coastal area with low altitude (196m). So it has low diurnal variability in day temperature. On the other hand, at Kavak located 50 km far from coastal area and at higher altitude (628 m), the differences between day and night temperature is higher and night temperature is lover compare to Samsun. Furthermore, high relative humidity (74-75%) at Samsun results lower evapotraspiration and higher available soil moisture even under same rainfall or irrigation. It was reported that season with heavy rainfall favored excessive vegetative growth while it caused lower seed yield (Karungi et al., 2000).

Over all the results indicated that cowpea is important forage crop with their yield and quality. Although the genotypes under test are not grown for forage purposes, their forage yields and quality are desirable. So, they can play an important role to fill forage gap by cutting for hay or by grazing during summer-autumn period when pasture yield is very low. Kiesling and Swartz (1997) reported that lambs grazing cowpea had greater total gain and carcass weight than lambs grazing sudangrass, fed corn/soybean meal or corn/whole cottonseed with certain ratios. Therefore there is need new studies to determine forage yield of different genotypes in different conditions and to improve high yielding forage type varieties in Turkey. The highest forage yield in both locations obtaining from one of the local cultivars, indicating the potential for selection of superior and better adapted genotypes for forage purpose.

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