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Correlation Analyses of Herbage Yield and Quality Components in Certain Sorghum × Sudangrass (*Sorghum bicolor L.×Sorghumsudanense Staph.)* Hybrid Cultivars

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ABSTRACT

The purpose of this research study was to evaluate phenotypic correlation between yield, quality and certain yield components, and to determine the direct and indirect effects of 13 different components on yield and quality in sorghum×sudangrass hybrids. The research was conducted in the trial area of the Bilecik Seyh Edebali University Faculty of Agriculture and Natural Sciences in Bilecik, Turkey, in the 2015 crop year. The randomized complete block design with 4 replications was used. In the study, Aneto and Teide sorghum×sudangrass hybrid varieties belonging to Fito Seed Company and Gözde 80, Leoti, Nes, Rox and Early Sumac sorghum×sudangrass hybrid varieties belonging to Mediterranean Agricultural Research Institute were used as the materials. Relationships between ADF (Acid Detergent Fiber) and NDF (Neutral Detergent Fiber) ratios, RFV (Relative Feed Value) and ME (Metabolic Energy) values and characters were investigated in the study, in addition to plant height, panicle height, leaf ratio, stem ratio, panicle ratio, green grass yield, hay yield and crude protein yields of sorghum×sudangrass hybrid varieties. Results show that the Teide variety showed the highest performance in terms of herbage yield, crude protein ratio, ADF, NDF, RFV and ME, while the lowest yields were obtained from Rox and Early Sumac. Crude protein ratio was found to significantly correlate with leaf ratio, ADF, NDF, RFV and ME similarly, leaf ratio correlated with ADF and NDF; ADF with NDF; RFV with leaf ratio, ADF and NDF; and ME with leaf ratio, ADF, NDF and RFV.

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Introduction

For many years in our country, Turkey, animal production has not reached the desired level due to the inadequacy of high quality roughage sources. Meadows and pastures, which are the most important roughage source, have been the subject of discussions as a result of extreme and untimely grazing. Quality roughage can be obtained by reducing the density of grazing in cultivated areas and forming and improving grasslands and pastures. In order to increase yields in coarse feed, it is necessary to diversify and improve feed crop agriculture, to evaluate marginal areas, and to enhance forage cultivation. Forage crop fields in Turkey have been tried to be expanded. One of the many alternative plants that can comply with different climate and soil conditions, by which the cultivation areas can be expanded, is the sorghum species and its hybrids (Çiğdem and Uzun, 2006).

In addition to being produced in tropical, subtropical and hot regions, sorghum can adapt to regions where drought and low precipitation dominate. For this reason, sorghum is an important feed plant (Li et al., 2010). It gives more yield than maize and many other plants because sorghum has roots twice more than those of maize. In addition, sorghum offers better efficiency by using water (Sanderson et al., 1992; Sanchez et al., 2002; Howell et al., 2008) and plant nutrients (N, P, K) more effectively than maize and many other plants (Bean et al., 2002; Kimbrough, 2002).

Sorghums have a larger habitus than many forages, are produced in the sleep period of cool-season forages and are, therefore, considered to be the ideal plant for the summer season. In recent years, a large portion of necessary daily green fodder has been obtained from sorghums. Some types of forage sorghums provide delicious, juicy green forage for animals. Sugar ratio in the stems of forage sorghums and grass yield of sorghums, which are long and leafy with tillering properties, are high, but their seed yield is low. Sudangrass, which falls into this group, has also been used for feed production purposes for many years. Sudangrass and sorghum ×sudangrass hybrids have superior characteristics such as forming a large mass on soil, being able to be mowed more than once a season, rapidly developing after the mow and coming to the harvest stage in a short period of time. So, in recent years, their areas of planting are growing rapidly (Açıkgöz, 2001).

Sorghum and Sudangrass, which have the highest quality compared to a larger number of forage crops, are produced within the system of a green forage conveyor and play an important role in tackling the issue of quality voluminous fodder shortage (Glamoclıja et al, 2010).

To obtain high yields of green grass unit-wise, it is necessary to develop new species and varieties with high yield potency and to determine species and varieties with high yield potency suitable for the region's ecological conditions with its existing species and varieties. Therefore, appropriate species and varieties must be determined, and criteria for improving breeding must be identified. In addition, the relationship between species and varieties and their mutual interactions on each other play an important role in breeding studies. As a result, traits among criteria determined in breeding studies play an important role in the selection of varieties. While correlation coefficients are used to determine the simple relationships among the properties to be examined, path analyses are utilized to determine in detail the direct and indirect effects influencing the efficiency.

Correlations express the level of dependence among traits. However, through correlation studies, it is often difficult to determine the actual mutual effects among traits out of numerous correlation coefficients.

This is achieved through a more qualified and complete analysis of the relationships among the properties studied, as well as a more precise establishment of direct interaction links. It also includes the separation of a specific property from the indirect effects on the dependent variable directly.

Division of correlations to direct and indirect effects gives a clearer view of traits, which can be seen as the backbone of breeding sorghum as a criterion for successful choice of a favorable genetic material.

While some traits have indirect effects, others have direct effects. For this reason, correlation results are similar for some pairs of traits, but different for some others (Ikanovic et al., 2010).

In this study, it was aimed to determine the yield and quality characteristics of certain sorghum×sudangrass hybrids and to determine the relationships between yield and quality criteria and other agricultural and morphological characteristics with simple correlation analyses.

Material and Method

This study was carried out with 4 replications according to the randomized complete block design in the application field of Bilecik Şeyh Edebali University Faculty of Agriculture and Natural Sciences in the growing season of 2015. In this study, Gözde 80, Leoti, Nes, Rox and Early Sumac varieties obtained from the Mediterranean Agricultural Research Institute were used as materials, as well as Aneto and Teide varieties that were obtained from Fito Seed. Plants were sown into 70×14 cm-wide areas. 8 kg N and 8 kg P_2O_5 per decare were given as fertilizer during planting, and 10 kg N as a top fertilizer.

In this study, soil samples were taken from 10 different locations from a depth of 0–30 cm in the test area in order to determine soil characteristics and were analyzed in the soil analysis laboratory of Eskisehir Transitional Zone Agricultural Research Institute. The results of this analysis, the physical and chemical properties of the soil, are given in Table 1. According to these results, the soil of the experimental area was sandy, loamy, and had medium level alkaline and salt. In addition, there was a medium amount of lime and organic matter in the soil and a small amount of phosphorus and potassium.

According to the values taken from the Bilecik Weather Station,the average temperature values in May, July, August, and September of 2015were 17.4, 23.2, 24.3, and 22.4°C, respectively throughout the period the survey was carried out. In June, the average temperature was found to be lower than the long-term average of 19.3 degrees. The corresponding relative humidity values were 62.5%, 74.6%, 61.9%, 63.3%, and 66.0%, respectively (May, July, August, September, June), and were higher than their respective long-term averages. In May and August 2015, average total precipitation values were 84.9 and 27.2 mm. These values were determined to be higher than the long-term average. However, the values were 21.9, 19.3 and 22.1 mm for June, July and September, respectively, and were found to be lower than their respective long-term average values.

Table 1 Physical and chemical characteristics of the soil in the trial area.

The soil of the experimental area	Values
pH	8.11
Saturation	54
EC (dS m^{-1})	0.73
Salt (%)	0.026
$CaCO_3$ (%)	8.3
O.M. (%)	1.5
K (kg da^{-1})	1.1
P_2O_5 (kg da^{-1})	3.5
Cu (cmol kg^{-1})	3.837
Fe (cmol kg^{-1})	7.944
Mn (cmol kg^{-1})	6.735
Zn (cmol kg^{-1})	1.790

Plants in the trial field were harvested during the milk-dough period. Before the harvesting, the field was separated by leaving 50 cm wide rows untouched from the sides of the parcels. The remaining part was taken as the harvest area. The plant height was found by measuring the lengths of 10 plants selected by chance in each parcel prior to the first form and taking their average. Forage yields of the plants, harvested and weighed in the milk-dough period, were calculated. Then, the numeric stock values were translated into decares. Dry matter (DM) yields were determined by weighting the dry matter samples in a forced oven at 78°C for 48 hours. Crude protein yields were determined by using the Kjeldahl method and multiplying the stock yields by dry matter yields (Kacar, 1984). Acid detergent fiber(ADF) and neutral detergent fiber (NDF) analyzes of dry matter samples were carried out using the Ankom Fiber Analyzer device (Fiber Analyser, ANKOM brand, A220 model) (Van Soest et al., 1991). Using these values, the metabolic energy (ME) and organic matter digestion grades of these plants were calculated.

Data obtained as a result of this research study were subjected to analysis of variance by using the MSTATC software program. Whether the differences between the averages were significant was determined by the Duncan test. Correlation analyses were performed using the SAS (SAS Inst., 1999) package program.

Result and Discussion

The number of flowering days (days), plant height (cm), panicle height (cm), leaf ratio (%), stem ratio (%) and panicle ratio (%) values obtained from certain sorghum×sudangrass hybrid varieties are shown in Table 2.

When Table 2 is examined, it is seen that there was no statistically significant difference between the varieties in terms of number of flowering days, but there was a difference (at 0.01% level) in terms of plant height, panicle height, leaf ratio, stem ratio and panicle ratio. The number of flowering days varied from 42 to 70 days. The plant heights were between 126.66 and 272.22 cm. The highest plant height was obtained from Gözde 80 while the lowest plant height was obtained from Teide. The panicle heights ranged from 32.65 cm to 19.00 cm. The highest panicle height was obtained from Aneto with a value of 32.65 cm, while the lowest panicle height was found in Nes with a value of 19.00 cm. Teide is a kind of transition, which did not form a panicle. The highest ratios of leaf and stem were obtained from Teide with values of 25.83% and 74.18%, respectively. Early Sumac had the lowest leaf ratio (14.55%) while Gözde 80 had the lowest stem ratio (52.43%). The highest panicle ratios among the varieties were obtained from Gözde 80 and Early Sumac with the values of 26.23% and25.28%, respectively. Our findings were similar to the findings reported by Çiğdem and Uzun (2006) and Balabanlı and Türk (2005).

Herbage yield (kg /da), dry matter yield (kg /da), crude protein ratio (%), ADF ratio (%), NDF ratio (%), RVF (%) and ME (Mcal kg^{-1} KM) values obtained from different sorghum×sudangrass hybrid varieties are given in Table 3.

Among the varieties, there was no statistically significant difference in terms of herbage yields, but there were statistically significant differences in dry matter yields, crude protein ratios,ADF (0.05%) and NDF ratios, RFV and ME values (0.01%) (Table 3). Herbage yields ranged from 3033 to 4611 kg/da. The highest dry matter yield was obtained from Teide with a value of 2228 kg/da, while the lowest dry matter yield was from Rox with a value of 692.9 kg/da. Our findings were similar to the findings described by Çiğdem and Uzun (2006) and Balabanlı and Türk (2005).

Table 2 Flowering days, plant height, panicle height and plant parts rate of certain sorghum×sudangrass hybrid varieties.

Varieties	Number of Flowering Days (days)	Plant Height (cm)	Panicle Height (cm)	Leaf Ratio (%)	Stem Ratio (%)	Panicle Ratio (%)
Gözde 80	42	272.2a	31.03a	21.08abc	52.43d	26.23a
Leoti	56	223.3b	25.30b	16.72cd	65.56b	17.70b
Nes	58	196.1bc	19.00c	17.55bcd	65.33b	17.13b
Rox	56	171.7c	22.45bc	19.65bcd	55.95cd	24.40a
Aneto	56	204.8bc	32.65a	22.30ab	61.03bc	16.65b
Teide	70	126.7d	0.00d	25.83a	74.18a	0.00c
EarlySumac	51	199.2bc	21.70bc	14.55d	59.70bc	25.28a
Average	55.57	199.1	21.73	19.67	62.03	18.20
LSD	n.s.	41.86**	5.166**	4.978**	6.536**	5.165**

*:P≤0.05 **: P≤0.01n.s.: non-significant

Table 3 Herbage yield, dry matter yield andquality components of certain sorghum×sudangrass hybrid varieties.

Varieties	Herbage Yield (kg/da)	Dry Matter Yield (kg/da)	Crude Protein Ratio (%)	ADF Ratio (%)	NDF Ratio (%)	RFV	ME (Mcal kg^{-1} KM)
Gözde 80	4611	1561.ab	10.32b	31.25c	51.33b	117.1a	2.11a
Leoti	3490	994.6b	8.45cd	35.83ab	56.60a	100.3b	1.98bc
Nes	4456	1117b	9.98b	31.18c	51.35b	117.1a	2.11a
Rox	3033	692.9b	8.94c	35.18b	55.90a	102.4b	2.00b
Aneto	3467	854.1b	9.43bc	30.93c	51.15b	117.9a	2.12a
Teide	3974	2228a	12.15a	29.63c	49.50b	123.7a	2.16a
EarlySumac	4578	1249b	7.51d	37.68a	57.25a	96.79b	1.93c
Average	3944	1242	9.53	33.09	53.29	110.7	2.06
LSD	n.s.	791.2*	0.9568*	1.915*	1.810**	6.387**	0.06436**

*0.05% **0.01%n.s.: non-significant

Table 4 Phenotypic correlation coefficients of yield and quality components incertain sorghum×sudangrass hybrid varieties

	FD	PH	PanH	LR	SR	PanR	ADF	NDF	RFV	M cal kg	CP	HY	DMY
FD	1												
PH	-.912												
PanH	-.812	-.827											
LR	.462	-.387	-.394	1									
SR	-.900	-.702	-.788	.328	1								
PanR	-.894	.711	-.785	-.670	-.921	1							
ADF	-.321	.144	.256	-.818	-.320	.588	1						
NDF	-.311	.158	.291	-.802	-.331	.591	-.991	1					
RFV	.330	-.170	-.299	-.816	.345	-.608	-.995	-.999	1				
M cal kg	.332	-.158	-.270	-.808	.332	-.593	-1.000	-.992	-.995	1			
CP	.510	-.379	-.594	-.874	.490	-.746	-.896	-.892	-.902	-.897	1		
HY	-.351	.335	-.082	-.217	-.053	.119	-.131	-.232	.198	.141	.102	1	
DMY	.349	-.295	-.706	.551	.511	-.639	-.495	-.562	.557	.496	.733	.503	1

Values written in bold were found to be significant at P≤0.050 level, FD: Flowering Days, PH: Plant Height, Pan H: Panicle Height, LR: Leaf Ratio, SR: Stem Ratio, Pan R: Panicle Ratio, CP: Crude Protein, HY: Herbage Yield, DMY: Dry Matter Yield

It is desirable to achieved high ratio of crude protein as equality criterion whereas to expect low ratios of ADF and NDF as indicators of digestibility. In accordance with this, the highest crude protein ratio and the lowest ADF and NDF ratios were obtained from the Teide variety with values of 12.15%,29.63% and 49.50%, respectively. The lowest crude protein ratio and the highest ADF and NDF ratios came from the Early Sumac variety with values of 7.51%, 37.68% and 57.25%, respectively. RFV value is the most important characteristic of the feed quality. The RFV value is checked to determine the quality of plants reaching harvest maturity. As the RFV value of fodder increases, its digestibility and flavor also increase (Schroeder, 1994; Mut et al., 2010). In this study, the highest RFV values were obtained from Teide, Aneto, Nes and Gözde 80, whereas the lowest RFV values were obtained from Early Sumac, Rox and Leoti. ME value, which is the energy obtained from the feed, parallels the RFV value (Moore and Undersander 2002).

Maleticet al. (2010) especially highlight the importance of phenotypic correlations, which point to possible changes under the influence of breeding methods to be applied. Therefore, correlations among 13 morphologic and productive traits of the analyzed sorghum×sudangrass hybrid cultivars were tested through the samples that were taken. Statistically significant differences with large magnitudes were found between individual traits, expressed by phenotypic correlation coefficients (Table 4). These significant correlations between some of the morphologic traits and their effects on green biomass yields are considered to be of great importance for developing new cultivars within-species as well as between-species hybrids. Simple correlation coefficients of the study showed the existence of strong, significant positive relations, and these effects had been expected. Herbage yield was not significantly correlated with the other quality traits of the plants in the study. The analysis of simple correlations showed that correlation coefficients the relationship among crude protein rate and leaf rate, ADF, NDF, RFV and ME values, among leaf rate, ADF and NDF values, among RFV values and leaf rate, ADF and NDF values, among ME values and leaf rate, ADF, NDF and RFV values were very statistically significant.

Conclusion

A number of findings that were of importance were identified based on the analyses carried out in this study in 2015.The earliest (most recent) flowering varieties were identified as Gözde80 and Teide, with 42 and70 days of flowering days, respectively. Plant heights ranged from 171.7 to 272.2 cm panicle heights, from 19.00 to 31.03 cm leaf ratios, from 14.55% to 25.83%; stem ratios, from 52.43% to 74.18%; and panicle ratios, from 0.00% to 26.23%.

The differences between the varieties in terms of herbage yield were not statistically significant, but the herbage yields ranged from 3033–4611 kg/da. The highest dry matter yield, the highest crude protein ratio, the lowest ADF ratio, the lowest NDF ratio, the highest RFV and ME values were obtained from the Teide variety.

In this research study13 different components on yield and quality in sorghum×sudangrass hybrids were investigated. In conclusion, the Teide variety showed the highest performance in terms of herbage yield, crude protein ratio, ADF and NDF ratios as well as RFV and ME values, while the lowest performances were obtained from Rox and Early Sumac. Finally, crude protein ratio was found to significantly correlate with leaf ratio, ADF, NDF, RFV and ME similarly, leaf ratio correlated with ADF and NDF; ADF correlated with NDF; RFV correlated with leaf ratio, ADF and NDF; and ME correlated with leaf ratio, ADF, NDF and RFV.

References

Açıkgöz E. 2001. Yem Bitkileri (3.Baskı). Uludağ Üni. Güçlendirme Vakfı, Yayın No:182, VIPAŞ AŞ, Yayın No:58, Bursa, 584s.

Balabanlı C, Türk M. 2005. Sorgum, Sudanotu Melez ve Çeşitlerinin Isparta Koşullarında Verim ve Kalite Özelliklerinin Belirlenmesi Üzerine Bir Araştırma. Süleyman Demirel Üniversitesi, Fen Bilimleri Enstitüsü Dergisi, 9-3.

Bean B, Mccollum T, Pietsch D, Rowland M, Porter B, Vanmeter R. 2002. Texas Panhandle Forage Sorghum Silage Trial.The Agriculture Program of Texas A&M University System. http://soilcrop.tamu.edu/publications/ pubs/ 910465silage.pdf.

Çiğdem İ, Uzun F. 2006. Samsun İli Taban Alanlarında İkinci Ürün Olarak Yetiştirilebilecek Bazı Silajlık Sorgum Ve Mısır Çeşitleri Üzerine Bir Araştırma. OMÜ Zir. Fak. Dergisi, 21 (1):14-19 J. of Fac. of Agric., OMU, 2006, 21(1):14-19.

Glamoclıja Dj, Jankovıc S, Maletıc R, Rakıc S, Ikanovıc J, Lakıc Z. 2010. Effect of nitrogen and mowing time on the biomass and the chemical composition of Sudanese grass, fodder sorghum and their hybrid. The Turkish Journal of Agriculture and Forestry, doi 10.3906/tar-0911-58.

Howell TA, Evett SR, Tolk JA, Copeland KS, Colaizzi PD, Gowda PH. 2008. Evapotranspiration of corn and forage sorghum for silage. World Environmental and Water Resources Congress. Ahupua'a, 1-14.

Ikanovıc J, Glamoclıja D, Maletıc R, Jankovıc S, Tabakovıc M, Zıvanovıc Lj. 2010.The genotype traits of forage sorghum, Sudan grass and their interspecies hybrid in the conditions of intensive nutrition.Genetika 42: 349-358.

Kacar B. 1984. Bitki Besleme Uygulama Kılavuzu. Ankara Üni. Zir. Fak.Yayınları, No:900, Uygulama Kılavuzu No:214, Ankara.

Kimbrough L. 2002. Corn and Sorghum for Silage. Extension Service of Mississippi State University. URL: http://msucares.com/pubs/infosheets/is485.htm.

Moore JE, Undersander DJ. 2002. Relative forage quality: Alternative to relative feed value and quality Index. Proceedings 13th Annual Florida Ruminant Nutrition Symposium, p.16 -32.

Mut H, Ayan İ, Acar Z, Basaran U, Onal-Asci O. 2010. The effect of different improvement methods on pasture yield and quality of hay obtained from the abandoned rangeland, Turkish Journal of Field Crops, 15(2):198-203.

Sanderson MA, Jones RM, Ward J, Wolfe R. 1992. Silage sorghum performance trial at stevensville: Forage Research in Texas. Rep. PR-5018. Texas Agric. Exp. Stn., Stephensville.

Sanchez AC, Subudhi PK, Rosenow DT, Nguyen HT. 2002. Mapping QTLs Associated with Drought Resistance in Sorghum (Sorghum bicolor L. Moench). Journal of Plant Molekuler Biology, 48: 713–726.

SAS Institute Inc. 1999. SAS Campus Drive, Cary, North Carolina 27513.September.

Schroeder JW. 1994. Interpreting Forage Analysis. North Dakota State University NDSU Extension Service AS-1080.

Van Soest PJ, Robertson JD, Lewis BA. 1991. Methods for Dietary Fibre, Neutral Detergent Fibre and Non-Starch Poly saccharides in Relation to Animal Nutrition. Journal of Dairy Science 74: 3583–3597.