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Gulumser D.D., Mut H.

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Effects of different Nitrogen rates on hay yield and some quality traits of Sudan grass and sorghum x Sudan grass hybrid varieties

D.D. Gulumser[1] and H. Mut[2]*

[1]Yozgat Directorate of Provincial Food Agriculture and Livestock, Yozgat (Turkey)
[2]Bozok University, Faculty of Agricultural and Natural Science, Department of Field Crops, Yozgat (Turkey)
*e-mail: hanife.mut@bozok.edu.tr

Abstract. This research was conducted to determine the effects of six nitrogen rates (0, 40, 80, 120, 160, 200 kg ha^{-1}) on the hay yield and some quality characteristics of Sudan grass and sorghum x Sudan grass hybrid grown in Yozgat ecological conditions in 2013-2014. As plant material, one Sudan grass and two sorghum x Sudan grass hybrids varieties were used. The experiment was arranged in split plot design with three replications. The average plant height, leaf ratio, hay yield, crude protein ratio, crude protein yield, ADF and NDF ratio were ranged from 200.9 – 205.5 cm, 36.02 – 39.90 %, 1.39 – 2.55 t/da, 8.17 – 11.90 %, 113.5 – 304.9 kg/ha, 37.51 – 40.31 % and 62.59 – 67.34 % in the 2013-2014 respectively. In this study P, K, Ca and Mg content of the varieties were found sufficient in both years. At the end of the two years study, in terms of hay and crude protein yield, Aneto and Bovital varieties which are sorgum x Sudan grass hybrids were superior with 80 kg ha^{-1} N rates under irrigated conditions.

Keywords. Sorghum x Sudan grass hybrids – Hay yield – Crude protein – ADF – NDF.

Effets de différents taux d'azote sur le rendement en foin et sur certaines caractéristiques de qualité chez Sudan grass et chez des variétés hybrides de Sorgho x Sudan grass.

Résumé. *Cette recherche a été menée afin de déterminer les effets de six taux d'azote (0, 40, 80, 120, 160, 200 kg ha^{-1}) sur le rendement en foin et sur certaines caractéristiques de la qualité chez Sudan grass et chez des variétés hybrides de sorgho x Sudan grass cultivées dans Yozgat en conditions écologiques en 2013-2014. Comme matériel végétal, 1 variété de Sudan grass et 2 variétés de sorgho x Sudan grass ont été utilisées. L'expérience a été organisée selon un dispositif split-plot avec trois répétitions. Dans cette étude, la hauteur moyenne des plantes, le nombre de feuilles, le rendement en foin, le ratio de protéine brute, le rendement en protéine brute, les ratios d'ADF et NDF, ont varié entre 200,9 – 205,5 cm, 36,02 – 39,90 %, 1,39 – 2,55 t/da, 8,17 – 11,90 %, 113,5 – 304,9 kg/ha, 37,51 – 40,31 % et 62,59 – 67,34 % en 2013-2014 respectivement. À la fin de l'étude de deux ans, on a compris que, en termes de rendements en foin et en protéines brutes, les variétés Aneto et Bovital, qui sont des hybrides de sorgho x Sudan grass, se sont avérées supérieures avec des taux de 80 kg ha^{-1} N et en conditions irriguées.*

Mots clés. *Hybrides sorgho x Sudan grass – Rendement en foin – Protéine brute – ADF – NDF.*

I – Introduction

Forage sorghum (*Sorghum bicolor* (L.) Moench) is an important crop due to its high yield and drought tolerance. It outperforms other cereals under various environmental stresses and generally is more economical to produce after a winter cereal harvest (Prostko *et al.,* 1998; Diallo, 2012). So, sorghum can be a profitable alternative crop for Türkiye. It is a little-known crop among farmers. Sorghum forage is a basic feed for livestock and especially valuable for feeding in all regions of the world (Afzal *et al.,* 2012). Sorghum is often used to produced silage, hay or pasture during summer. Sudan grass (*Sorghum sudanense* (Piper.) Stapf) has relatively thin stems; tillers cover a large area when conditions permit, and it can regrow rapidly. Thus, it is better suited to pasturing than other types of sorghum. Hybrid Sudan grass crosses usually yield slightly more than true Sudan grass varieties in multiple-cut harvest systems (Anderson and Volesky, 2013).

Nitrogen fertilizer is an expensive but essential input for optimum production of non-leguminous crops on rotation. Despite nitrogen being one of the most abundant elements on earth, nitrogen deficiency is certainly the most common nutritional problem affecting crops worldwide. The application of fertilizer has been known to increase yield of sorghum (Diallo, 2012). Timing is crucial in nitrogen application and plant growth stage, season and leaching must be taken into consideration.

This research was conducted to determine the effects of six nitrogen fertilization rates (0, 40, 80, 120, 160, 200 kg ha^{-1}) on the hay yield and some quality characteristics of Sudan grass and sorghum x Sudan grass hybrids in Yozgat ecological conditions.

II – Materials and methods

This study was conducted in the experimental fields of the Agriculture and Natural Sciences Faculty of Bozok University in Yozgat in 2013 and 2014 growing seasons. The soil taken from 30 cm depth is classified as clay loam with pH: 8.20, $CaCO_3$: 7.93 %, P_2O_5: 8.62 kg da^{-1} and K_2O: 48.47 kg da^{-1}. Organic matter is low in experimental fields. The total rainfall of this area is 111.6 and 371.1 mm, and average temperature of growing season is 16.0 and 16.8°C (2013 and 2014, respectively). The effects of six nitrogen doses (0, 80, 120, 160, 200 kg ha^{-1}) on the hay yield and some quality characteristics of Sudan grass and sorghum x Sudan grass hybrids were investigated. Gözde 80 (a Sudan grass variety registered in Turkey), Aneto and Bovital (hybrid introduced material) were used as plant material. The experiment was arranged in split plot design with three replications. The varieties was the main plots, N doses was the sub plots. The net plot size 3 x 4 m = 12 m^2 and total experimental field size 994 m^2. The seed dose was 30 kg ha^{-1}. Sowing dates were 24.05.2013 (first year) and 13.05.2014 (second year). Recommended dose of phosphorus is 80 kg ha^{-1}. Half dose of nitrogen and full dose of phosphorus were applied at the time of sowing while the remaining nitrogen half was applied at plant high of 40-50 cm. Maturity at harvest was determined using Zadok's scale (Zadok *et al.,* 1974). Harvest was done at late milk stage (Zadok scale 77). Plants were harvested one time in the first year (10.09.2013) and two times in the second year (08.08.2014 and 21.10.2014). Investigated characters were plant height, leaf ratio, hay yield, crude protein ratio, crude protein yield, ADF, NDF, P, K, Ca and Mg ratio. To determine dry weight per plant, plant samples were dried at 60°C until constant weight. After cooling and weighing, the samples were ground to pass through 1 mm screen for quality analyses. Crude protein (CP), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF) and mineral contents were determined by using Near Reflectance Spectroscopy (NIRS, 'Foss XDS') with the software package program 'IC-0904FE'. Crude protein yield was calculated by multiplying dry matter yield with crude protein content. The data were analyzed using the statistical package program SPSS 11.0 V. (SPSS Inc., Chicago IL, USA). Probabilities lower than 0.05 were considered significant. Duncan's multiple range tests was used to separate the treatment means.

III – Results and discussion

According to the results, the effect of the N rate was significant on the investigated morphological and quality traits (Table 1). Plant height was not influenced by the varieties and N rates. Plant height ranged from 199.4 to 207.9 cm among varieties and 191.7 to 209.3 cm among N rates. Plant height was higher 2014 than 2013 (205.5 and 200.9 cm, respectively). Plant height was higher on the second year because total rainfall in 2014 was higher than 2013. Plant height in previous studies was 194 cm in Sudan grass, and ranged from 60 to 300 cm in hybrids (Karataş, 2011; Nazlı, 2011). Leaf ratio among the varieties was determined between 36.86 and 37.85%. Average hay yield (HY) was significantly ($P<0.01$) affected by genotype, N rates and year and it ranged between 1.89 (Gözde-80) and 2.03 t da^{-1} (Aneto) among genotypes, and 1.92 (Control) and 2.10 t da^{-1} (at 80 kg N ha^{-1}) over the N doses (Table 1).

Aneto and Bovital had better hay yield than Gözde 80. The highest hay yield was measured at 80 kg ha^{-1} N rates, and in 2014 year. Similar results were reported by Balabanlı and Turk (2005), Cecen *et al.,* (2005), Gunes and Acar (2005), Kırbas (2012), and Ozkose *et al.* (2015). The highest crude protein ratio was determined in Aneto with 10.84 %. According to N doses, average crude protein ratio ranged from 9.71 to 10.37%. Crude protein ratio was higher in 2014 compared to 2013 (11.90 *vs* 8.17 %, respectively). Crude protein yield ranged from 190.1 to 233.8; 197.7 to 230.4; and 113.5 to 304.9 t da^{-1} (varieties, N doses and years, respectively).

Table 1. Means of yield and some quality traits Sudan grass and sorghum x Sudan grass hybrids

	PH	LR	HY	CP	CPY	ADF	NDF
Varieties							
Gözde80	202.5	37.85	1.89 *b*	9.65 *b*	190.1 *b*	40.02 *a*	67.44 *a*
Aneto	199.4	36.86	2.03 *a*	10.84 *a*	233.8 *a*	37.65 *b*	62.73 *b*
Bovital	207.9	37.67	2.01 *a*	9.63 *b*	203.7 *b*	39.07 *ab*	64.73 *b*
N Doses (kg ha^{-1})							
0	200.8	36.38	1.92 *b*	10.06	198.8 *b*	40.26	65.79
40	204.8	38.42	1.94 *b*	9.71	202.1 *b*	38.79	64.28
80	209.3	36.01	2.10 *a*	10.34	230.4 *a*	39.37	65.71
120	207.5	40.35	2.00 *b*	9.99	212.2 *ab*	38.09	64.48
160	205.7	37.05	1.95 *b*	10.37	214.2 *ab*	38.89	65.18
200	191.7	36.55	1.93 *b*	9.75	197.7 *b*	38.05	64.34
Year							
2013	200.9	36.02 *B*	1.39 *B*	8.17 *B*	113.5 *B*	37.51 *B*	62.59 *B*
2014	205.5	38.90 *A*	2.55 *A*	11.90 *A*	304.9 *A*	40.31 *A*	67.34 *A*

PH: Plant height (cm); LR: Leaf ratio (%); HY: Hay yield (t da^{-1}); CP: Crude protein (%); CPY: Crude protein yield (t da^{-1}); ADF: Acid detergent fiber (%); NDF: Neutral detergent fiber (%).

There was significant difference in ADF content among varieties and years. ADF content was not affected by nitrogen rates. The highest ADF content was found in Gözde 80 (40.02 %) and Bovital (39.07 %). Aneto had lower ADF content in comparison with other varieties. The highest ADF content was determined in the control fertilization dose and, there was no significant difference between N doses. ADF ratio was higher in 2014 compared to 2013 (35.71 and 40.31%, respectively). NDF content was significantly affected by varieties and year but was not affected by N rates. Sudan grass (Gözde 80) with 67.44% had the highest NDF content. The P, K, Ca and Mg content of varieties were sufficient for sheep and cow requirements in both years. The highest P and K ratio was determined in Aneto variety. Ca and Mg content in this study ranged from 0.50 to 0.67% and 0.15 to 0.22%, respectively (Fig. 1). Gestating or lactating beef cow minerals needs 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). Tejada *et al.* (1985) reported that forage should contain at least 2 g kg^{-1} Mg and 3 g kg^{-1} Ca for the ruminant. For this respect, P, K, Ca and Mg contents of the forage in all the genotypes were higher than animal needs recommended by the previous studies (Ayan *et al*., 2012).

At the end of the two years study, in terms of hay and crude protein yield, Aneto and Bovital varieties and at the dose of 80 kg ha^{-1} N are suggested under irrigated conditions.

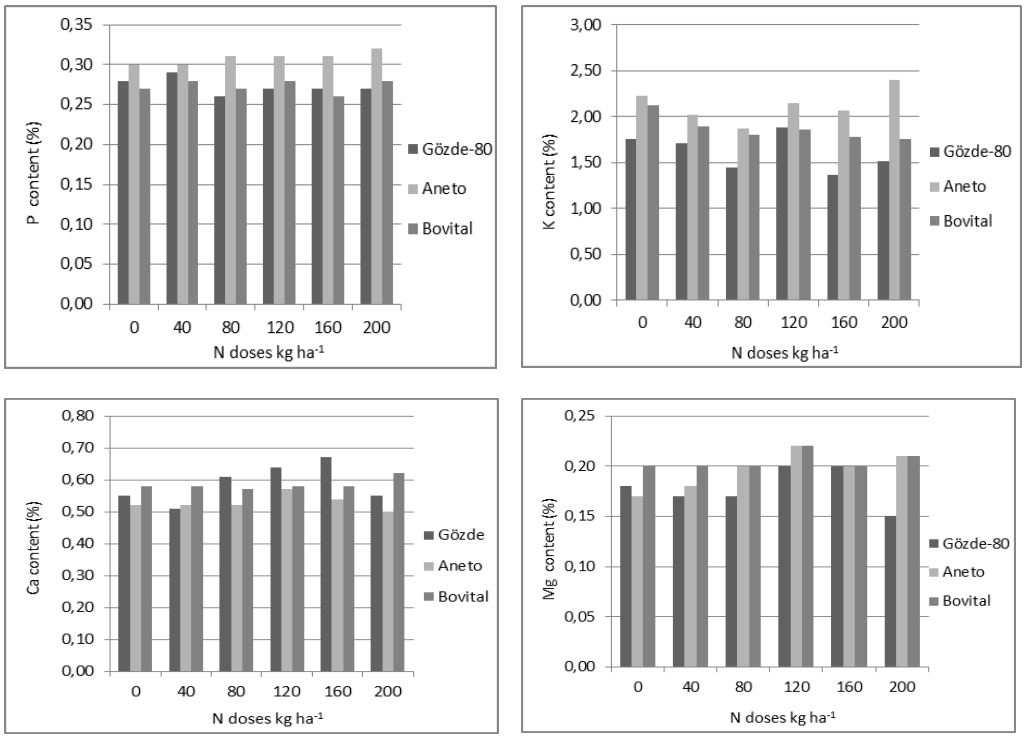

Fig. 1. Mineral content of sudan grass and sorghumxsudan grass hybrids over the mean.

References

Afzal M., Ahmad A. and Ahmad AU.H., 2012. Effect of nitrogen on growth and yield of sorghum forage (*Sorghum bicolor* (L.) Moench cv.) under three cuttings system. In: *Cercetări Agronomice în Moldova*, Vol. XLV, No. 4 (152).

Anderson B.E. and Volesky J.D., 2013. Summer Annual Forage Grasses. http://extensionpublications.unl.edu/assets/html/g2183/build/g2183.htm.

Ayan I., Mut H., Basaran U., Acar Z. and Onal Aşcı O., 2012. Forage potential of cowpea (*Vigna unguiculata* L. WALP). In: *Turkish Journal of Field Crops* 2012 17(2), p. 135-138.

Balabanlı C. and Turk M., 2005. A research on determination of yield and quality characteristics of sorghum, sudangrass hybrid and cultivars in Isparta ecological conditions. Suleyman Demirel University. In: *J. of Institute of Natural and Applied Sciences* 9(3).

Cecen S., Oten M. and Erdurmus C., 2005. Assesment of sorghum (*Sorghum bicolor* L.), sudangrass (*Sorghum sudanense* L.) and corn (*Zea mays* L.) as second crop in the Coastal Region of West Mediterranean Belt of Turkey. Akdeniz University. In: *J. of the Faculty of the Agricultural* 18(3), p. 337-341.

Diallo S., 2012. Effect of Genotypes and Nitrogen on Grain Quality of Sorghum. Kansas State University, MSC Thesis, 109 p.

Gunes A. and Acar R., 2005. The determination of growing possibilities of sorghum-sudangrass cultivars as second crop under Karaman ecolojical conditions. In: *J. of Selcuk Agricultural Science* 19(35), p. 8-15.

Karatas Z., 2011. A Research on the Effects of the Different Harvest Times on Herbage Yield and Quality components of the some Sorghum x Sudan Grass Hybrids as Doubled Crop under Çukurova Conditions. Cukurova University, Institute of Natural and Applied Sciences, MSc Thesis, 49 p.

Kırbas R., 2012. Determination of Yield and Quality Characteristics of some Silage Sorghum x Sudanense Moench L. Varieties Raised in Samsun Ecological Conditions. Ondokuz Mayis University, Institute of Natural and Applied Sciences, MSc Thesis, 84 p.

Nazlı R.I., 2011. Use of Possibilities of some Organic Residues in Sorghum x Sudangrass Hybrid (*Sorghum bicolor* x *Sorghum bicolor* var.sudanense) Cultivation. Cukurova University, Institute of Natural and Applied Sciences, MSc Thesis, p. 69.

NRC (National Research Council), 1996. *Nutrient requirements of beef cattle* (7th Ed.) National Academy Press, Washington, D.C.

Ozkose A., Mulayim M. and Acar R., 2015. Effect of row spacing on some yield and yield components of silage sorghum cultivars in Konya conditions. In: *J. of Selçuk Agricultural Science* 2(1), p. 10-18.

Prostko E.P., Muir J.P. and Stokes S.R., 1998. The influence of harvest timing on forage sorghum silage yield and quality. In: *Texas Agric. Exp. Stn*., Stephensville, TX. Accessed Jun. 15, 2012.

Tejada R., McDowell L.R. Martin F.G. and Conrad J.H. 1985. Mineral element analyses of various tropical forages in Guatemala and their relationship to soil concentrations. In: *Nutrition Reports Inter*., 32: 313.

Zadok J.C., Chang, T.T. and Konzak C.F., 1974. A decimal code for growth stages of cereals. In: *Weed Res.* 14, p. 415-421.