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The Yield and Agronomic Characteristics of Silage Sorghum and Sorghum-Sudangrass Hybrid Cultivars Under Kirsehir Ecological Conditions

Hakan KIR[1] Başak DURSUN ŞAHAN [1]
[1]Ahi Evran University, Faculty of Agriculture, Department of Field Crops, Kirsehir, Turkey

***Corresponding Author**
E-mail:hakankir@ahievran.edu.tr

Abstract

This study was carried out in 2016-2017 vegetation periods under the ecological conditions of Kirsehir. This experiment was conducted in completely randomized block design with tree replicates to determine the adaptation abilities of some sorghum and Sorghum-Sudangrass hybrid cultivars (Aneto, Greengo, Teide, Gözde 80, Sugar Graze, Early Sumac, Rox, Gardavan, Jumbo) in Kırşehir ecological conditions.The results showed that the plant height and weight, number of leaves, stem diameter, leaf and steam ratio, herbage yield were determinedas 216.4-287.1 cm and 168.2-383.7 gr, 7.1-10.7 pcs/plant, 8.9-16.8 mm, 17.3-27.1 % and 72.4-83.1 % 3278.1-6754.5 kg da^{-1} respectively. To conclude Greengo and Jumbo were preferable cultivars in Kırşehir ecological conditions.

Keywords: Sorghum, SorghumxSudangrass, Plant height, Yield, Agronomic characteristics

INTRODUCTION

Cultivation of sorghumxsudangrass hybrids obtained by crossing of sorghum (Sorghum bicolor (L.) Moench) and sudangrass (Sorghum sudanense (Piper.) Stapf.) has a great potential to close the forage deficit. Sorghum grown in arid and irrigated agricultural areas can easily adapt to different climate and soil conditions. In addition, advantages such as efficient water use compared to corn, low fertilizer requirement, erosion and weed control reduce the production costs. Besides the use of seeds and steams in different forms at animal feeding, sorghum and sorghumxsudangrass hybrids, which are also used as both green fodder and silo feed, are important in animal husbandry. Producing higher green biomass and digestible nutrients from a unit area provides both more efficient and higher quality feed source for producers. The importance of sorghum is constantly increasing with its high yield and feed quality. In order to close high quality forage deficit in our country, planting acreage of forage crops needs to be expanded and type of forage crops should be diversified. Sorghum is an alternative forage crop in arid areas with irregular precipitation regime observed throughout the year, high temperature and inadequate precipitation during the summer. Widespread cultivation of sorghum and sorghum x sudangrass hybrids in water stressed regions or regional adaptability can be achived by revealing good adaptation capability and desired characteristics of cultivars [1]. Several studies have conducted to reveal some agronomic characteristics of sorghum, a C4 type plant, and sorghum-sudan grass hybrids Acar, Akbudak [2], Güneş and Acar [3], Parlak and Özaslan [4], Geren and Kavut [5], Karadağ and Özkurt [6], Salman and Budak [7].The aim of this research is to determine some agricultural characteristics of sorghum (Sorghum bicolor (L.) Moench) and sudangrass (Sorghum sudanense (Piper.) Stapf.) hybrids, which may be an alternative feed source in the province of Kırşehir that has an important potential for livestock.

MATERIAL and METHOD

This research was carried out under dryland conditions in Kırşehir ecology (39 ° 08 ‘K, 34° 06’ D and 1084 m height) during 2016 and 2017 for two years. Aneto, Greengo, Teide, Sugar Graze, Gardavan, Jumbo Sorghum x Sudangrass hybrids and Gözde 80, Early Sumac, Rox, sorghum Cultivars were used as materials of the study. The soils of study area had clayey loam texture, were slightly alkaline (pH 7.96), non-saline (0.02%), highly calcareous (35.29%), low in organic matter (1.09%) and available phosphorus (1.9 kg da^{-1}) and rich in potassium (48 kg da^{-1}). Data provided by the State Meteorology Department for 2016, 2017 and long-term averages showed that monthly average temperatures were 22.33, 22.38 and 20.98 ºC and total precipitations were 63.9, 34.8 and 66.4 mm, respectively (Table 1).

Table 1. Climate data for the growing seasons that the study was conducted

Months	Average Temperature (°C)			Total Precipitation (mm)		
	2016	2017	Long Years	2016	2017	Long Years
June	21.0	20.7	19.6	16.1	18.4	36.8
July	24.2	23,9	23.1	5.8	0.4	6.8
August	25.7	23,5	22.9	-	16.0	4.9
September	18.4	21,4	18.2	42.0	-	11.6
Average/Total	22.3	22.4	21.0	63.9	34.8	66.4

A seed bed of 4-5 cm depth on 4 rows in each plot was opened by leaving a 60 cm interrow distance using a hand marker. In both years, seeds were planted by hand to the seed beds on June 2 at a standard of 1.5 kg da^{-1} sowing rate. The research was conducted with three replications according to the Randomized Blocks Experimental Design. The plot area in the study was 2.4mx5m=12m^2. Plant nutrients were given at a rate of 20 kg da^{-1} N, 10 kg da^{-1} P_2O_5 and K_2O to the sorghum plots (Salman and Budak 2015). At harvest time, a row on each side of a plot and 30 cm edges of the two middle rows were excluded from the experiment as side effects [6]. Sorghum cultivators harvested at the soft dough stage [5]. Results were subjected to the analysis of variance according to the randomized block experimental design using MSTAT-C statistical software. Differences in the data were compared by the LSD method [8].

RESULTS AND DISCUSSION

Table 2. Agronomic Traits of Silage Sorghum and Sorghum-Sudangrass hybrid cultivars.

	2016	2017	Mean	2016	2017	Mean
	-------- Steam Ratio (%) ---------			-------- Leaf Ratio (%) --------		
ANETO	74.9 cd**	80.5 a**	77.7 b**	27.5 a**	26.6 a**	27.1 a**
EARLY SUMAC	79.4 ab	73.0 c	76.2 bc	17.5 c	17.0 d	17.3 d
GARDAVAN	82.5 a	83.8 a	83.1 a	25.1 b	19.7 cd	22.4 c
GÖZDE 80	74.5 cd	76.9 b	75.7 bc	25.5 ab	22.5 bc	24.0 bc
GREENGO	75.8 cd	69.0 d	72.4 d	24.2 b	20.6 bcd	22.4 c
JUMBO	78.1 bc	76.0 bc	77.1 bc	23.7 b	24.0 ab	23.8 bc
ROX	77.0 bc	74.8 bc	75.9 bc	19.9 c	17.6 d	18.7 d
SUGAR GRAZE	72.9 d	75.6 bc	74.3 cd	18.5 c	18.2 d	18.4 d
TEİDE	77.9 bc	75.4 bc	76.7 bc	25.0 b	26.1 a	25.6 ab
MEAN	77.0	76.1	76.6	23.0 A++	21.4 B	22.2
LSD (%5)	Y:NS C:2.7 YxC:3.8** CV:2.9			Y:0.9**C:1.9 YxC:2.7**CV:7.1		
	-------- Stem Diameter (mm) --------			------- Number of Leaves (pcs/plant) --------		
ANETO	12.0 bcd**	12.4 b**	12.2 b**	9.6 ab*	9.3 b**	9.4 b**
EARLY SUMAC	13.0 b	12.9 b	13.0 b	7.8 d	8.1 cd	7.9 c
GARDAVAN	9.5 de	9.3 cd	9.4 c	8.1 cd	7.4 de	7.8 cd
GÖZDE 80	9.1 e	8.6 cd	8.9 c	7.5 d	6.7 e	7.1 d
GREENGO	12.7 bc	10.6 bcd	11.7 b	9.5 abc	9.3 b	9.4 b
JUMBO	13.5 b	12.8 b	13.2 b	10.4 a	11.1 a	10.7 a
ROX	14.6 ab	11.5 bc	13.1 b	8.9 bcd	8.7 bc	8.8 b
SUGAR GRAZE	10.3 cde	8.1 d	9.2 c	8.5 bcd	7.0 de	7.8 cd
TEİDE	16.4 a	17.2 a	16.8 a	8.9 bcd	9.6 b	9.3 b
MEAN	12.4 A+	11.5 B	11.9	8.8	8.6	8.7
LSD (%5)	Y:0.7* C:1.6 YxC:NS CV:10.9			Y:NS C:0.7 YxC:NS CV:6.7		
	-------- Plant Height (cm) --------			-------- Plant Weight (g)--------		
ANETO	280.1 ab**	279.1 ab**	279.6 a**	263.3 bc**	236.7 bc**	250.0 bcd**
EARLY SUMAC	218.9 c	239.1 cd	229.0 bc	203.3 cd	180.0 bc	191.7 de
GARDAVAN	270.3 ab	277.9 ab	274.1 a	279.0 b	253.3 b	266.2 bc
GÖZDE 80	271.2 ab	285.1 a	278.1 a	179.7 d	156.7 c	168.2 e
GREENGO	297.0 a	277.3 ab	287.1 a	283.3 b	273.3 b	278.3 b
JUMBO	266.3 b	265.5 abc	265.9 a	382.0 a	360.0 a	371.0 a
ROX	219.0 c	213.8 d	216.4 c	177.7 d	193.3 bc	185.5 e
SUGAR GRAZE	264.6 b	217.0 d	240.8 b	216.0 bcd	203.3 bc	209.7 cde
TEİDE	189.5 d	245.5 bcd	217.5 c	367.3 a	400.0 a	383.7 a
MEAN	253.0	255.6	254.3	261.3	250.7	256.0
LSD (%5)	Y:NS C:22.1 YxC:31.3** CV:7.2			Y:NS C:57.0 YxC:NS CV:18.4		
	-------- Green Forage Yield (kg da^{-1})--------					
ANETO	5167.8 cd**	5388.9 b**	5278.3 c**			
EARLY SUMAC	4613.9 de	5542.2 b	5078.1 c			
GARDAVAN	3857.2 f	3424.4 de	3640.8 e			
GÖZDE 80	3822.8 f	2733.3 e	3278.1 e			
GREENGO	5858.9 b	6914.4 a	6386.7 ab			
JUMBO	6486.7 a	7022.2 a	6754.5 a			
ROX	4409.5 ef	4378.9 c	4394.2 d			
SUGAR GRAZE	4232.2 ef	4008.9 cd	4120.6 d			
TEİDE	5547.2 bc	6728.9 a	6138.1 b			
MEAN	4888.5	5126.9	5007.7			
LSD (%5)	Y:NS C:436.1 YxC:616.8** CV: 7.2					

CV: Coefficientof variation,Y:Year, C: Cultivar,NS = Not Significant.

*Means followed by the same letter in the same column are statistically not significant ($p<0.05$). **Means followed by the same letter in the same column are statistically not significant ($p<0.01$). +Means followed by the same letter in the same line are statistically not significant ($p<0.05$). ++Means followed by the same letter in the same line are statistically not significant ($p<0.01$).

Steam Ratio;

Changes in steam ratio among cultivars and year x cultivars interaction were statistically significant at p<0.01 level while it was not significant for years (Table 2). The highest steam ratio (83.1%) among the cultivars was obtained from the Gardavan and the lowest (72.4%) from the Greengo cultivar Statistically significant difference in steam ratio for yearxcultivar interaction indicates the differences in steam ratio of cultivars at two different years. Gözde 80 and Greengo cultivars were in the same group at the first year of study while they were included in different groups at the second year of the study. In a research conducted at two different sites including Aneto, Gardavan and Greengo cultivars, Salman and Budak [7] obtained the highest steam ratio with Greengo (77.4%) in Bayındır location and Aneto (77.1%) in Ödemiş location while the lowest steam ratio (75.5% and 72.9%) in both locations was obtained by Gardavan cultivar. Differences in the data obtained in studies results from the differences in the duration of study as well as irrigation status, temperature and, in particular, responses of different cultivars to different ecological conditions.

Leaf Ratio;

The difference in leaf ratio was significantly (P<0.01) between years, cultivars and yearxcultivar interaction (Table 2). The highest leaf ratio among the cultivars was obtained from the Aneto cultivar (27.1%) and the lowest leaf ratio was obtained from the Early Sumac cultivar (17.3%). However, there was not statistically different between Aneto and Teide cultivars in terms of high leaf ratio. Similarly, leaf ratio among Early Sumac, Sugar Graze and Rox cultivars was not different in terms of low leaf ratio. The first-year average leaf ratio (23.0%) was higher than the second year (21.4%). Differences in environmental conditions between years along with genetic potentials of the cultivars may cause to such differences in leaf ratio. Teide and Greengo cultivars were included in the same group at the first year of the study, while they were in different statistical groups at the second year of study, which led to the statistically important yearxcultivar interaction. The results reported by Acar, Akbudak [2], Güneş and Acar [3], Geren and Kavut [5], Salman and Budak [7], Keskin, Yılmaz [9] were in agreement with our findings.

Stem Diameter;

Statistical analysis indicated that year (P<0.05) and cultivars (P<0.01) were significant. Year x cultivar interaction was not significant (Table 2). The highest steam diameterwas obtained from Teide cultivar with 16.8mm while the lowest steam diameter was 8.9mm in Gözde cultivar. Gözde 80, Sugar Graze and Gardavan cultivars were placed in the same statistical group.The steam diameter of the cultivars varied depending on years.The average steam diameter in the first year(12.4mm) was significantly higher than the second year (11.5 mm).The steam which allows standing ofplants upright on soil surface, increases forage yield, however high steam ratio is not desirable because of containing substances such as cellulose, hemicellulose and lignin, which are difficult to digest and negatively affect the herbaceous quality [10]. The findings of steam diameter obtained in our study are ower than the results reported by Soya, Avcıoğlu [10], similar to the findings of Güneş and Acar [3] and Parlak and Özaslan [4] higher than those reported by Acar, Akbudak [2] and Özköse, Mülayim [11].

Number of Leaves;

The differences in cultivars were significantly important (P<0.01) (Table 2). The highest number of leaves among cultivars was obtained from Jumbo cultivar (10.7 plants/ plant) and the lowest number of leaves was from Gözde 80 cultivar (7.1 pcs/plant). Gözde 80, Gardavan and Super Graze cultivars formed the group with low leaf number. The average number of leaves in the first year (8.8 pcs /plant) was higher than the number of leaves in the second year (8.6 pcs/plant) of the study. The results of our study are in agreement with the findings of Acar, Akbudak [2], Güneş and Acar [3] and Parlak and Özaslan [4].

Plant Height;

The differences in single plant height between cultivars and year x cultivar interactions were significant at p<0.01 level while it was not significant for years (Table 2). The highest single plant height was 287.1 cm in the Greengo cultivar and the lowest single plant height was 216.4 cm in Rox cultivar. However, the difference in high leaf ration between Greengo and Jumbo Gardavan, Gözde 80 and Aneto cultivars was not statistically different. Similarly, the difference in low leaf ration between Rox and

Early Sumac and Teide cultivars was also not significant. The average plant height the first year (253.0 cm) was significantly lower than the second year (255.6 cm). Jumbo and Sugar Graze cultivars were placed in the same group at the first year of the study, while Sugar graze was in a lower statistic group, which led to important yearxcultivar interaction. Our results on single plant height were higher than those reported by Acar, Akbudak [2], Keskin, Yılmaz [9] and Özköse, Mülayim [11], lower than the findings of Güneş and Acar [3] and Geren and Kavut [5]. The differences in single plant height may be attributed to different ecology, cultivar, maintenance and practices.

Plant Weight;

Single plant weight was significantly different for cultivars (P<0.01). Years and year x cultivar was not significant (Table 2). The Jumbo (371.0 g) and Teide (383.7 g) cultivars had the highest single plant weight whereas Rox (185.5 g) and Gözde 80 (168.2 g) cultivars had the lowest single plant weigh. The differences among cultivars have been related to the genotype structure of cultivars [12]. The findings obtained in our study were higher than those reported by İptaş and Yılmaz [12] and Özköse, Mülayim [11], in contrast lower than the results of Acar, Akbudak [2]. The differences in results may be attributed to differences in maintenance and agricultural practices besides the responses of cultivars to the different ecologies that experiments conducted.

Green Forage Yield;

Effects of years, cultivars and year x cultivar interaction on green herbage yield were significantly different (P<0.01) (Table 2). The highest green herbage yield (6754.5 kg da^{-1}) was obtained with Jumbo cultivar, while the lowest herbage yield (3278.1 kg da^{-1}) was obtained with Gözde-80 cultivar which was included in the same statistical group with Gardavan cultivar. The average green forage yield the second year (5126.9 kg da^{-1}) was significantly higher than the first year (4888.5 kg da^{-1}). The green herbage yield of cultivars significantly varied depending on years. Greengo and Jumbo cultivars were included in different groups at the first year, while they were placed in the same group at the second year,

which resulted in significant year x cultivar interaction. The results obtained in our study were in agreement with those reported by Geren and Kavut [5] and Keskin, Yılmaz [9]. In contrast to our findings, Acar, Akbudak [2], Karadağ and Özkurt [6], Çeçen, Öten [13] reported lower green herbage yield compared to our findings.

CONCLUSION

Sorghum and sorghum sudangrass hybrids, in the ecologies where the summers are warm and dry like the Kırşehir province, grow well when they are irrigated and they are also more resistant to water stress in arid periods compared maize. In areas with humidity problem, studies on silage maize as well as sorghum and sorghum sudangrass hybrids that are not known in the region should be carried out and cultivars with high crop yields and quality should be offered to the farmers of the region. The results of mean two-year study showed that Greengo and Jumbo cultivars, which are in the same statistical group in terms of high plant height and weight, have also yielded the highest green forage yield. Greengo and Jumbo cultivars in Kırşehir ecological conditions are considered the preferable cultivars.

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