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Araştırma Makalesi/*Research Article (Original Paper)*

Determination of Agricultural Characteristics of Some Silage Sorghum and Sudan Grass Varieties Grown as Second Product

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Abstract: The aim of this paper was to investigate some plant traits and yield of silage sorghum cultivars and sudangrass grown as the second crop in the center of agricultural research and applying, in the 2015 year. In the experiment was used three sorghum (Rox, Early Sumac, and Leoti), two sorghum x sudangrass hybrid (Nutri Honey and Hay Day) and one, Sudan-grass (Gözde 80) under irrigated conditions of Iğdır. The experimental layout was completely randomized block design with three replicates. Plant height of cultivars (cm), dry matter ratio (%), green herbage and dry matter yield (kg da^{-1}), leaf ratio (%), the stem ratio (%), ear rate (%), the number of leaves per plant and the plant weight (g) was determined in the trial. According to results of experiments, plant heights (197.1-299.4 cm), green yield (3482-8337 kg da^{-1}), dry matter ratio (32.0-38.0 %), dry matter yield (1141.2-2658.1 kg da^{-1}), leaf ratio (15.7-20.0%), the stem ratio (71-78 %), the panicle ratio (7.3-9.3%), the number of leaves (9.5-12.5), the plant weight (375.5-875.4 g $plant^{-1}$) was obtained. Additionally, positive and a significant correlation was observed between the of plant weight and the dry matter yield on the green herbage yield, but the effects of plant height, leaf, stem, leaves rates were insignificant. These results suggested that Hay Day, Leoti and Early Sumac will be able to grow as a silage in respect of green herbage and dry matter yields under the ecological condition of this region.

Keywords: Cultivar, Sorghum, Sudan-grass, Yield

Bazı Silajlık Sorgum ve Sudan Otu Çeşitlerinin İkinci Ürün Verim ve Bazı Bitkisel Özelliklerinin Belirlenmesi

Öz: Araştırma, ikinci ürün silajlık olarak yetiştirilen 3 adet sorgum (Rox, Early Sumac ve Leoti), 2 adet sorgum x sudan otu melezi (Nutri Honey ve Hay Day) ve 1 adet sudan otu (Gözde 80) çeşidinin verim ve bazı bitkisel özelliklerinin belirlemek amacıyla, Iğdır Üniversitesi Tarımsal Uygulama ve Araştırma Merkezi'nin deneme alanlarında 2015 yılında sulu şartlarda yürütülmüştür. Deneme tam şansa bağlı tesadüf blokları deneme desenine göre 3 tekerrürlü olarak kurulmuştur. Araştırmada çeşitlerin bitki boyu (cm), yaş ot verimi (kg/da), kuru ot oranı (%), kuru ot verimi (kg/da), yaprak oranı (%), sap oranı (%), yaprak sayısı (adet/bitki) ve bitki ağırlığı (g) belirlenmiştir. Çeşitlerin bitki boyu 197.1-299.4 cm, yaş ot verimi 3148.6-8337.6 kg/da, kuru ot oranı % 32.0-38.0, kuru ot verimi 1141.2 -2658.1 kg/da, yaprak oranı % 15.7-% 20.0, sap oranı % 71.7-78.0, salkım oranı % 7.0-9.3, yaprak sayısı 9.5-12.5 adet/bitki ve bitki ağırlığı 375.5-875.5 g/bitki arasında bulunmuştur. Yaş ot verimi üzerine bitki ağırlığı ve kuru ot veriminin etkileri önemli ve pozitif yönde olurken, bitkisel özelliklerden bitki boyu, yaprak, sap, salkım oranları ile yaprak sayısının verimler üzerine etkisi önemsiz bulunmuştur. Araştırma sonuçlarına göre; Hay Day, Early Sumac ve Leoti çeşitleri yaş ot ve kuru ot verimleri açısından bölge ekolojisi için tavsiye edilebilir.

Anahtar kelimeler: Çeşit, Sorgum, Sudan otu, Verim

Introduction

Sorghum bicolor (L.) Moench) an annual plant, can be grown in arid climates and unfavorable soil conditions, in which corn can not be grown due to its ability to grow in inadequate saline soils in nutrients (Zerbini and Thomas 2003; Ali et al. 2009; Borghi at al. 2013). Sorghum is also a prominent forage crop growing in many regions of the world (Mahmood and Honermeie 2012) and can adapt to heat and drought conditions better than maize (Nordquist and Rumery 1967). Many sorghum varieties are long season, or photoperiodic, producers and do not flower until day-length shortens and they have and extended vegetative phase grow period with longer availability of maintenance or better quality feed (Ian 2004). The forage sorghum is known to be better in terms of quality of total dry matter and digestible dry matter without any change quality in physiological dough stage (Torrecillas et al. 2011). Furthermore, there is a wide range physical characteristics between and within crop types. However, little information is available on the growth habit of the genotype cultivated in southern Iğdır, Turkey. Therefore, the current study aimed to determine some plant traits and yield of silage sorghum cultivars and sudan-grass grown as the second crop.

Materials and Methods

The research was conducted to determine the yield and yield components of the second crop silage cultivated 3 sorghum (Rox, Early Sumac and Leoti), 2 sorghum x sudangrass hybrid (Nutri Honey and Hay Day) and sudangrass (Gözde 80) carried out in the trial areas of the Agricultural Application and Research Center of Iğdır. The experimental layout was completely randomized block design with three replications. Some characteristics of the soil from the experiment are given in Table 1, and according to the samples taken from 0-30 and 30-60 cm soil depth, the soil contains 6.53% lime in the clayey structure and shows a slight alkaline pH between 7.98-8.03 and the soil at the experimental sites was dominantly clay loam properties of low soil fertility.

Table 1. Some characteristics of the soil from the experiment

Soil depth (cm)	Saturation (%)	Soil structure	Lime ($CaCO_3$)	Total salt (mmhos/cm)	pH	P_2O_5 (kg da^{-1})	K_2O (kg da^{-1})	Soil organic matter
0-30	83	Clay-loam	6.53	1.8	7.98	8.0	343	1.6
30-60	68	Clay-loam	6.53	1.8	8.03	3.7	248	1.3

Climatic Conditions

The average monthly atmospheric temperature of Igdır in the experimental period was 14.32 ºC, a total precipitation was 122.3 mm m, the humidity was 42.45 %, respectively (Table 2). The temperature in July and September in the Igdır location was lower than in other months. Sorghum water use is mainly affected by its growth stages and environmental demands. For high production, requires approximately 450 to 650 mm of water during a growing season (FAO 2002). The sorghum is a drought-tolerant crop, it is often preferred by producers in cases of expected water stress (Assefa and Staggenborg 2010). As can be shown in Table 2, total rainfall and temperature is not enough for plant growth and development.

Table 2. Some climatic data from the experimental area conducted in Igdır.

Climatic values/Months	May	June	July	August	September	Average/Total	
Monthly average temp.ºC	27.80	27.80	0.30	14.30	1.40	14.32	71.6
Monthly average rainfall, mm	18.70	24.90	28.40	26.90	23.40	24.46	122.3
Average relative humidity, %	51.00	41.30	35.10	41.70	43.70	42.56	212.8

*: Records of Regional Directorate of Meteorology in Igdır 2015.

Plot size was 17.5 m^2, 5 rows with 0.7 m space and inter space 15 cm. Sowing was on 24.06.2015, with the help of a marker and 9 523 of seeds were sowed into the each plot and then watered immediately.

Each plot was fertilized with 16 kg da^{-1} nitrogen and 8 kg da^{-1} phosphorus fertilization, half of the nitrogen fertilizer is spread out with sowing time and the rest is hand out after plants reached to about 50 cm. According to field capacity, the plots were irrigated by sprinkler system until the plants reach to at full boom stage and then flooded by irrigation and plants were harvested in the late-dough stage on 15 October, 2015. Weeding was conducted manually several times as required. After removal of edge effects from each plot, sorghum genotypes were harvested at 10 cm above the ground level in the remaining three rows. Firstly, green herbage yield was weighed by immediately after the edge effects of plots were discarded (Acar 1995), approximately 1500 g plant sample was taken from each parcel, and then was dried in the air and then 60 ºC in the oven. Dry matter yield was obtained from each parcel, dry matter ratio is multiplied by green herbage. According to the chance to represent the parcels received 10 plants, plant height, leaf number and ratio, stem and panicle amount and these rates were determined (Mülayim et al. 2009).

Results and Discussion

Plant height (cm)

Cultivars also showed a significant effect on some of the traits under consideration. In terms of plant height, the significant differences were statistically between the plant lengths of the varieties (Table 3). Nutri Honey, Hay Day and Gözde 80 were higher length, while Leoti, Erlay Sumac and Rox varieties are shorter than the other varieties. In the experiment, Gözde 80 were with 299.4 cm, Hay Day with 284.6 cm and Nutri Honey with 267.9 cm in plant height in the same group, on the other hand, Leoti (214.2 cm), E. Sumac (199.5 cm) and Rox (197.1 cm) were shorter. The results of the sorghum varieties in the plant length (197.1-299.4 cm) was higher than the findings with by (Acar et al.

2002; Aydınoğlu 2005; Karadağ and Özkurt2014), otherwise these are consistent with the results by (Yılmaz 2000). Sudangrasses have smaller stems and more slender leaves than the forage sorghums. However, variations in plant height among varieties, as numerous researchers have been reported that varieties can be caused from the interaction of genetic and environmental conditions.

Green Herbage Yield (kg da^{-1})

The green herbage yields of the varieties varied between 3610.9 and 8337.6 kg da^{-1} in this experiment and the Hay Day variety produced more biomass (8337.6 kg da^{-1}) (Table 3). Nutri Honey with 3482.0 kg da^{-1}, Gözde 80 with 3610.9 kg da^{-1}, and Rox with 3984.5 kg da^{-1} were found to be in the same yield group, similar results were reported for forage sorghum cultivars by some researchers conducted by Van conditions (Yılmaz 2000). Aydın and Albayrak (1995) cited that the green yield of sorghum cultivars ranged from 4.4 to 6.2 tons; Baytekin et al. (1996) obtained from green grass yields of 10.6, 9.3 and 7.1 tones, respectively, from the P-911, NK 300 and Rox silage sorghum varieties in Harran conditions. İptaş and Yılmaz (1995) concluded that highest green herbage yield from 8841.4 kg da^{-1}. Yılmaz et al. (2002) investigated the effects of plant density on Sorghum x sudan varieties and the green yields varied between 3656-4281 kg da^{-1} and the hay yield varied between 1378-1529 kg da^{-1}, with the most favorable plant density was 100 plants/m^2. Öten and Çakmakçı (2010) cited that the silage yield of varieties of silage was 9428.5 to 9688.7 kg da^{-1}; dry hay yields ranged from 1391 to 3725 kg da^{-1} and the highest hay yield was obtained from Early Sumac variety as averages of sowing times. The findings of this investigate were higher than data by Karadağ and Özkurt (2014) found that in the silage sorghum varieties grown as secondary crops in the Tokat-Kozova ecological conditions, green herbage grass yields were 2128.2-4764.3 kg da $^{-1}$. In addition to these, Parlak ve Parlak (2006) resulted that Early Sumac cultivar was more efficient than Rox, are verified with the current results.

Dry matter ratio (%) and Dry matter yield (kg da^{-1})

The dry matter of the ratios of genotypes were statistical significant difference between them and the rations ranged from 32.0% to 38.0%, were Gözde 80 with 37.0% Leoti with 36.7% and Rox with 38%. However, Gözde 80, Leoti and Rox that were harvested at the same time seem to mature earlier than the other varieties. The assessment of varieties in terms of dry natter yield is statistically significant (Table 4). Dry matter content of forage crops at harvest is one of the most important factors for successful ensilage (Miron et al.2006). The dry matter yields of the varieties ranged from 1141.2 kg da^{-1} to 2658.1 kg da^{-1}, and were obtained from Nutri Honey and Hay Day genotypes, expressing the lowest and highest yields, respectively. The results of in both green herbage yield and dry matter yield, the cultivar Early Sumac produced more forage than cultivar Rox. The findings obtained from the current trial are in agreement with the findings of some researchers by Parlak ve Parlak (2006). On the other hand, green and dry matter yield od E. Sumac, Rox and Gözde cultivars had 4783.9, 4763.0 and 4357.5; 1378.7 1477.0 and 1409.8 kg da^{-1}, respectively, no differences between among the mentioned cultivars (Akdeniz et al. 2002). As in the case of green herbage yield, hay yields are closely related to the genetic makeup of varieties and environmental factors. Similar and different results have been made in studies conducted in different ecological regions of our country in different varieties. Baytekin et al. (1996) silage sorghum named Fs 25E in the conditions of Harran, 2395.6 kg hay yields, Keskin et al. (2005) hay yields, 1615-1783 kg da^{-1}; Atış et al. (2012) pointed out that mean dry matter yields of cultivars were ranged from 18.75 t ha^{-1} to 20.15 t ha^{-1}; Karadağ and Özkurt (2014) found dry matter yields between 935.0-1924.0 da^{-1} in the Tokat-Kozova ecological conditions. Similary, Balabanlı and Türk (2005) showed that the lowest yields were obtained from Rox and Early Sumac variety with sorgum hybrids and varieties. Çiğdem ve Uzun (2006) showed that Rox, Early Sumac and Gözde-80 varieties yielded at 2727, 3511 and 2378 kg da^{-1}, respectively; dry matter yields were 493.8, 727.4 and 686.6 kg da^{-1}, they were in accordance with our results. On the other hand, in a study of intercropping of alfalfa and some forage plants, the highest hay yield were obtained in intercropping of alfalfa and sorghum (Başaran et al. 2018). However, Ikanović et al. (2014) have shown that there have been significant fluctuations in production indicators between the genotypes.

Leaf Number and Leaf Rate (%)

Leaf ratio is considered as a quality factor in forage plants is considered as an important feature in terms of animal nutrition. There was a significant difference in the number of leaves between sorghum (Rox, Early Sumac, Leoti), sorghum x sudangrass hybrids (Nutri Honey, Hay Day) and sudangrass (Gözde 80). In this case, the leaf number of Hay Day variety was 12.5, which is more than other varieties, and the lowest number of leaves in Leoti variety was 9.5. Leaf ratios of sorghum varieties were between 15.7 % and 20.0%, respectively, with no statistical difference were obtained from E.Sumac and Rox varieties respectively. These findings are agreement with the results by Hosaflıoğlu (1998) found that leaf ratio was 17.8-27.7% and Başaran and Mülayim (2011), leaf number per plant was 11.4 (Leoti). Forage sorghums are typically taller, leafier, and later maturing than grain sorghum hybrids.

Stem and Panicle ratio (%):

There was a slightly significant difference between varieties in terms of stem ratio. The stem ratios of the varieties used in the study ranged from 71.7% to 78.0% and were obtained from the Gözde 80 and E.Sumac variety respectively. The large proportion of important silage quality varies depending on both genetic and ecological factors. These results of current study are not accordance with the results by Keskin et al. (2005) found that the highest stem rate was obtained in the Grass II and P-988 varieties (68.38 and 67.60%) and the lowest stem ratio was in the Gözde-80 variety (63.52%). There was a slightly significant difference between the varieties which showed a variation of panicle ratio 7.0% to 9.3%, however, the panicle ratio of Gözde 80 was higher than the others. Atış et al. (2012) reported that the stem ratio was higher than the leaf and panicle ratio on the whole plant basis.

Plant weight

The highest plant weight per plant was obtained from Hay Day (875.5 g) The plant weight of Nutri Honey and Gözde 80 was found to be lowest than the other varieties (Table 3). The results of this experiment were higher than Köse et al. (2015) concluded that plant weight per plant was 32.99-68.82 g plant. However, some correlations have been found in bilateral correlations between yield and plant characteristics in sorghum varieties conducted in Iğdır ecological conditions. A very significant and positive relationship (r^2 = 0.968 **) was found between green herbage yield and dry matter yield (Table 5). Similarly, a very important and positive relationship was found between green herbage yield and plant weight (Akdeniz et al. 2006). A very significant but negative relationship was also observed between leaf ratio and stem ratio and panicle ratio (Table 5). Erić and Cupina (2004) sudangrass yield depends on the time of sowing as well and identified a positive correlation between yield and growing period. Kaplan and Kara (2014) examined the relationship between physiological characteristics of yield silage genotypes with different characteristics and yield, confirmed that have a negative relationship between green grass yield and plant height.

Table 3. Plant height, green herbage, hay yield of sorghum varieties, 2015

Varieties	Plant height (cm)	Green herbage yield (kg da^{-1})	Dry matter ratio (%)	Dry matter yield (kg da^{-1})
Rox	197.1 c	3984.5 c	38.0 a	1516.5 cd
E.Sumac	199.5 c	6005.8 b	32.7 b	1918.7 bc
Leoti	214.2 bc	5829.3 b	36.7 a	2143.2 b
Nutri Honey	267.9 ab	3482.0 c	32.7 b	1141.2 d
Hay Day	284.6 a	8337.6 a	32.0 b	2658.1 a
Gözde 80	299.4 a	3610.9 c	37.0 a	1331.1 d

*There is no significant difference between the averages indicated by the same letters a (P<0.05).

Table 4. The number of leaf, stem and panicle ratio and number of leaves and plant weight of sorghum varieties in the whole-plant, 2015

Varieties	Leaf ratio (%)	Stem ratio (%)	Panicle ratio (%)	Leaf number	Plant weight (g)
Rox	20.0	72.0 b	8.0 ab	11.3 ab	425.4 c
E.Sumac	15.7	78.0 a	6.3 b	10.7 ab	630.6 b
Leoti	18.7	73.3 ab	8.0 ab	9.5 b	645.4 b
Nutri Honey	18.0	74.5 ab	7.3 ab	11.2 ab	363.9 c
Hay Day	18.7	74.3 ab	7.0 ab	12.5 a	875.5 a
Gözde 80	19.0	71.7 c	9.3 a	10. ab	375.1 c

**There is no significant difference between the averages indicated by the same letters a (P<0.05).

Table 5. Correlation coefficients related to relations between characteristics investigated

Agronomic characteristics	Plant length (cm)	Green herbage yield (kg/da)	Dry matter ratio (%)	Dry matter yield	Leaf ratio (%)	Stem ratio (%)	Pcnicle ratio (%)	Leaf number
Plant length (cm) (cm)	-							
Green herbage yield (kg da^{-1})	-,055	-						
Dry matter ratio (%)	-,126	-,461	-					
Dry matter yield (kg da^{-1})	-,103	,968**	-0.243	-				
Leaf ratio (%)	0.76	-,187	0.655**	-,0.45	-			
Stem ratio (%)	-,148	,348	-,668**	,215	-,884**	-		
Pcnicle ratio (%)	,188	-,433	,458	,356	,440	-,809	-	
Leaf number	,256	,215	-,168	,152	,073	-0.016	-,123	-
Plant weight (g/plant)	-,040	0.978**	-,439	,956**	-,176	,330	-,411	,173

* p<0.05; **. p<0.01.

Conclusion

In order to reduce total costs on farms and to sustain agricultural production, it is necessary to provide a new approach to this problem on a global level. The biomass of silage sorghum [*Sorghum bicolor* (L.) Moench] may replace maize, whose profitability decreases in semi-arid regions of the world. Growing forage sorghum as an alternative to silage maize and utilizing smaller amounts of nitrogen allows using natural resources more rationally and increases production efficiency (Rakić et al. 2013).

Which type of sorghum and variety chosen for planting will depend on if the intended use is for grazing, hay, green chop or silage. The results of the annual research indicate that Hay Day, Leoti and Early Sumac will be able to grow both as a silage in respect of green herbage and dry matter yields under the ecological condition of this region.

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