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YIELD AND QUALITY CHARACTERISTICS OF SUNFLOWER SILAGES IN HIGHLANDS

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ABSTRACT

This research was carried out to compare the yield and quality characteristics of four sunflower (*Helianthus annuus* L.) genotypes (i.e., confectionery Tekirdag landrace, confectionery Erzurum landrace, oilseed Sirena and oilseed C70165 hybrids) and one corn (*Zea mays* L.) genotype (i.e., SZE TC-513 hybrid) in the Agriculture Faculty of Ataturk University in the east of Turkey during the period between 2005 and 2006. The study was designed in a randomized complete block design with five treatments replicated three times. The genotypes were evaluated in terms of forage properties as well as chemical and physical properties of silages in both years. According to the results, the corn genotype had better yield and silage qualities than sunflower genotypes. But crude protein contents of silages of sunflower genotypes were superior in comparison to the corn genotype. Also amongst sunflower genotypes, confectionery Tekirdag and Erzurum landraces had slightly higher silage qualities than oilseed sunflower hybrids.

Keywords: Sunflower, Corn, Silage, Crude protein, Acid detergent fiber, Neutral detergent fiber
Abbreviations: ADF - Acid detergent fiber; NDF - Neutral detergent fiber; CP - Crude protein

INTRODUCTION

Farmers have some problems in meeting the required feed for livestock in some regions of the world. Silage in regions being insufficient of forage production is shown as important alternative feed source (Yildiz et al., 2008). Good silage is one of the best feeds for providing energy, protein, mineral and vitamin for ruminants (Mafakher et al., 2010). Main silage crops such as corn, sunflower and sorghum produces higher fresh and dry matter yield of than those of legume and grass forage crops per unit area.

Corn is commonly used for silage in different regions, but it is negatively affected by spring late frosts, autumn early frosts, cold climates and summer droughts in highlands having short vegetation period. Because of these negative conditions in highlands, in order to decrease the risk in cultivation, it must be found new plants for silage in addition to silage corn. Sunflower having better cold and drought tolerance (Ozduven et al., 2009) is an important plant for silage in highlands. For these reasons, sunflower, less affected by autumn early frost conditions, remains longer in the field and completes the growing period. Moreover, sunflower is less affected by bird damage. It has higher fresh yield, dry matter yield and crude protein content than that of corn (Mafakher et al., 2010). Sunflower silage is generally recognized to be adequate for dry cows, steers and low milk producers (Peiretti and Meineri, 2010).

Sunflower genotypes, hybrids and cultivars show important differences in terms of dry matter yield (Mello et al. 2006a; De Rezende et al. 2007) and quality properties (Ko et al. 2005; Jayme et al. 2007). The aim of this study was to compare the yield and quality characteristics of four sunflower genotypes and one corn genotype for silage in highlands of Eastern Anatolia.

MATERIALS AND METHODS

Experiment Location

The experiment was carried out in the Agriculture Faculty of Ataturk University in the East of Turkey (39° 55' N, 41° 61' E at an altitude of 1800 m) during 2005 and 2006. The soils were clay with neutral reaction (pH 6.9), poor in lime (3.6%) and total nitrogen (0.05%) and rich in available phosphorus (137 kg ha^{-1}). Mean annual temperatures in the region for 2005, 2006 and long term average are 5.1, 6.4 and 4.2 °C, respectively. Total annual precipitations and mean relative humidity in the region for the same periods are 480.0, 357.4 and 400.9 mm, and 69.5, 68.8 and 64.3 %, respectively.

Field applications and experimental design

Four sunflower genotypes (i.e., confectionery Tekirdag landrace, confectionery Erzurum landrace, oilseed Sirena hybrid and oilseed C70165 hybrid), and one corn genotype (SZE TC-513 hybrid) were seeded on 31 May

2005 and 26 May 2006. Sunflowers and corn were sown in rows at a seeding rate of 5 and 40 kg ha^{-1}, respectively. The research plots size were 2.8 m wide and 3 m long and consisted of 4 rows spaced 0.7 m (Kara et al. 1999; Ozer et al. 2003) apart with a 2.5 m buffer zone. Sunflowers and corn fertilized with 80 kg ha^{-1} P_20_5 in seed bed preparation term in each year. Nitrogen was applied 100 kg ha^{-1} N for sunflower and 150 kg ha^{-1} N for corn as half during seed bed preparation and the other half during 40-50 cm plant height in each year. The experiment was arranged in a randomized complete-block design with five treatments replicated three times. Control of weeds was mechanically made by hand-hoeing at 20-25 cm plant height and at 50 cm plant height. Irrigation was made five times during July and August in each year. Sunflowers and corn were harvested at completed flowering stage (Tan and Tumer, 1996) and at milk dough stage-dough seed stage (Gucuk and Baytekin, 1999), respectively. First year data in this study were taken from master thesis belong to Erdal Guney.

Measurements and chemical analysis

Sunflowers and corn in each plot were weighted to determine fresh yield as soon as harvested and then were oven dried at 105 ^{0}C for 24 h to find dry matter yield. Plant heights, ear and head rates were found as mean of ten plants. Chopped samples filled and compacted into glass jars with three replications in each year. Incubating silages were opened to analyze for chemical and physical properties after two months of ensiling. The Kjeldahl method and a Vapodest 10 Rapid Kjeldahl Distillation Unit (Gerhardt, Konigswinter, Germany) were used to found total N (Bremner 1996) in silages. ADF, NDF and pH measurements of silages were determined according to Akyildiz (1986) and Kiliç (1986). Physical properties such as color (according to 0, 1 and 2 quality scores), structure (according to 0, 1, 2 and 4 quality scores) and smell (according to 0, 2, 4, 8 and 14 quality scores) were found by the method of Kiliç (1986). As very good total score 18-20, good total score 14-17, middle total score 10-13, utility total score 5-9 and low total score 0-4 divided into quality classes.

Statistical analysis

The results were statistically evaluated by using MSTAT-C procedures and mean separations were made on the basis of least significant differences (LSD) (Steel et al., 1997).

RESULTS AND DISCUSSION

Corn is negatively affected by frosts, but sunflower can complete its growth in the regions having early autumn frost risk. Sunflower can be used as silage plant in addition to the corn in regions having frost risk in some years. For these reasons, determine of ideal sunflower genotypes for silage is very important for animal feeding in highlands.

The highest fresh yield was found in silage corn (68802 kg ha^{-1}). Sunflower genotypes were similar in terms of fresh yield in mean of two years (Table 1). Similarly, Goncalves et al. (1999) found similar fresh yield amongst four sunflower genotypes. In addition,

Table 1. Fresh yield, dry matter rate, dry matter yield, plant height, ear-head rate of four sunflower genotypes and one corn (across 2 years)

Plants	Fresh Yield (kg ha^{-1})	Dry Matter Rate (%)	Dry Matter Yield (kg ha^{-1})	Plant Height (cm)	Ear-Head Rate (%)
Corn	68802 A	25.77	17730 A	209 A	30.50 B
Tekirdag	47331 B	25.35	11998 B	175 AB	43.47 A
Erzurum	51400 B	26.18	13457 B	183 AB	43.75 A
Sirena	49508 B	25.67	12709 B	171 B	44.95 A
C70165	42594 B	25.90	11032 B	152 B	44.73 A
Mean	51927	25.77	13385	178	41.48
Y	*	*	ns	ns	**
P	**	ns	**	**	**
Y x P	ns	ns	ns	ns	**

Y: Year, P: Plant, *Significant at %5 level, **Significant at %1 level.

Mello et al. (2006a) reported that four sunflower hybrids had no differences in terms of fresh yield in the mean of different seeding times. In contrast, Tomich et al. (2003) stated that twelve sunflower hybrids had differences in fresh yield. There are no differences in terms of dry matter rate amongst four sunflower genotypes and one corn genotype (Table 1). Goncalves et al. (1999) reported similar dry matter rate in four sunflower genotypes except one. In addition, Mello et al. (2006a) stated that four sunflower hybrids had no differences in terms of dry matter rate in the mean of different seeding times. The highest dry matter yield was determined in silage corn (17730 kg ha^{-1}). Sunflower genotypes were similar in terms of dry matter yield in mean of two years (Table 1). Similar dry matter yields were found by Goncalves et al. (1999) in three of four sunflower genotypes, by Tomich et al. (2003) in many of twelve sunflower hybrids and by Mello et al. (2006a) in four sunflower hybrids in the mean of different seeding times. The plant height was the highest in corn hybrid (209 cm) followed Erzurum landrace (183 cm), Tekirdag landrace (175 cm), Sirena hybrid (171 cm) and C70165 hybrid (152 cm) (Table 1). In another study, Mello et al. (2006a) reported that four sunflower hybrids had no differences in plant height in the mean of different seeding times. Whereas Tomich et al. (2003) was found differences in plant height amongst twelve sunflower hybrids. Ear rate of corn was 30.50%. Sunflower genotypes were similar in terms of head rate (Table 1). Also, Goncalves et al. (1999) determined similar head rates amongst four sunflower genotypes in three times of four different harvest times. In another study, head rates of sunflowers are similar amongst four hybrids in two times of three seeding times (Mello et al., 2006a). But in contrast, Tomich et al. (2003) reported that sunflowers cultivars had differences in head rate. Differences between years was found important in fresh yield ($p<0.05$), dry matter rate ($p<0.05$) and ear-head rate ($p<0.01$). Change over the years of fresh yield, dry matter rate, ear-head rate and year x plant interaction in the ear-head rate of sunflower genotypes and corn were shown in Figure 1 and 2.

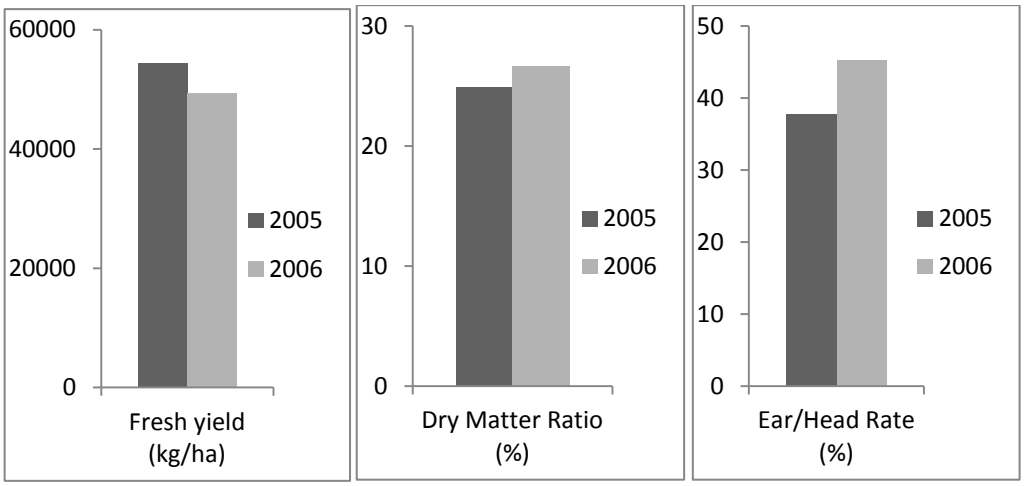

Figure 1. Change over the years of fresh yield, dry matter rate and ear-head rate of four sunflower genotypes and one corn

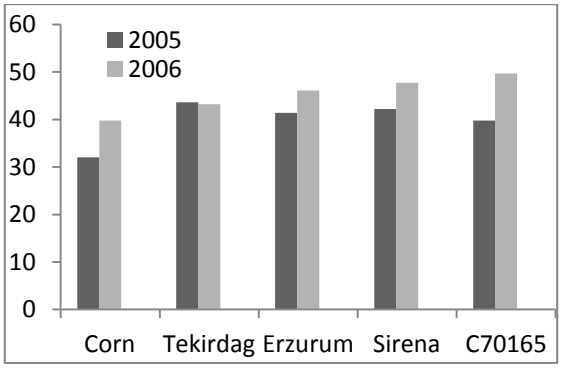

Figure 2. Year x plant interaction in the ear-head rate of four sunflower genotypes and one corn

Table 2. Crude protein, acid detergent fiber, neutral detergent fiber, and pH of four sunflower genotypes and one corn silages (across 2 years)

Bitkiler	CP (%)	ADF (%)	NDF (%)	Silage pH
Corn	9.53 D	26.64 C	34.77 C	3.96 C
Tekirdag	12.75 A	32.11 B	36.27 BC	4.64 A
Erzurum	10.71 C	33.60 AB	38.68 AB	4.67 A
Sirena	11.89 B	34.29 AB	35.96 BC	4.46 B
C70165	11.24 C	35.02 A	39.59 A	4.34 B
Mean	11.22	28.33	37.05	4.41
Y	ns	ns	ns	ns
P	**	**	*	**
Y x P	**	ns	ns	ns

Y: Year, P: Plant, *Significant at %5 level, **Significant at %1 level.

Significant differences were found in crude protein content of four sunflower genotypes and one corn silages ($p<0.01$) (Table 2). Similarly, other studies reported that sunflower cultivar silages had differences in crude protein content (Tomich et al. 2004; De Rezende et al. 2007). In contrast, Mello et al. (2006b) reported that four sunflower hybrid silages are similar in terms of crude protein content in the mean of different seeding times. The crude protein content was the highest in Tekirdag landrace silage (12.75%), followed Sirena hybrid (11.89%), C70165 hybrid (11.24%), Erzurum landrace (10.71%) and corn hybrid (9.53%). Other studies stated that corn silage had lower crude protein content than that of sunflower silage (Demirel et al. 2008; Mafakher et al. 2010). There are important differences in ADF ($p<0.01$) and NDF ($p<0.05$) content of four sunflowers and one corn silages (Table 2). Also other studies reported differences in ADF (Tomich et al. 2004; Mello et al. 2006b) and NDF (De Rezende et al., 2007) amongst sunflower cultivars or hybrids silages. The corn hybrid had lower ADF (26.64%) and NDF (34.77%) contents than that of sunflower genotypes. In another study, Demirel et al. (2008) found similar ADF and lower NDF content in sunflower in comparison to corn. Tekirdag landrace silage in ADF and Sirena hybrid silage in NDF had the lowest contents amongst sunflower genotypes. But those silages were statistically the same group with other sunflower genotypes except C70165. Differences were determined in pH of four sunflowers and one corn silages (Table 2). Similarly, Tomich et al. (2004) and De Rezende et al. (2007) reported that silages of sunflower cultivars had differences in pH. On the other hand, Goncalves et al. (1999) stated similar pH amongst four sunflower genotypes. Also, another study determined that four sunflower hybrid silages were similar in pH in the mean of different seeding times (Mello et al., 2006b). Corn hybrid had the lower pH value than that of four sunflower genotypes. Also other studies determined that corn silage had lower silage pH of than that of sunflower (Demirel et al. 2008; Mafakher et al. 2010). Sirena and C70165 hybrids had the lower pH value than those of Tekirdag and Erzurum landraces amongst sunflower genotypes. Result of evaluating physical characteristics was determined to be corn in good quality, Tekirdag and Erzurum landraces in utility quality and Sirena and C70165 hybrids in low quality (Table 3). Also in another study, Mafakher et al. (2010) stated that both corn and sunflower were very good quality in evaluating physical characteristics.

Table 3. Physical characteristics of four sunflower genotypes and one corn silages (across 2 years)

Plants	Color	Structure	Smell	Total	Quality
Corn	2	4	8	14	Good
Tekirdag	1	2	2	5	LL Utility
Erzurum	1	2	4	7	Utility
Sirena	1	1	2	4	Low
C70165	1	1	2	4	Low

CONCLUSION

Potential of different sunflower genotypes in comparison to corn have been determined in the study in Erzurum conditions. According to research results, corn had superior properties in fresh, dry matter yield and plant height as well as ADF, NDF, pH and physical characteristics of silage. But sunflower in regions having shorter growing season may be used as silage plant in addition to corn, because sunflower can complete its growth by being less affected during frosts in years having autumn early frost risk. Although there are no significant differences among sunflower genotypes, confectionery Tekirdag and Erzurum landraces that have more branching and plant height had slightly higher silage qualities than oilseed hybrids. It is required that superior yielding sunflower genotypes are determined and that silage quality is increased by using appropriate additives. Consequently, it is appropriate that researchers should focus on studies that increase yield and quality of sunflower for silage.

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