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Araştırma
Research

EFFECTS OF DIFFERENT CULTIVARS AND FERTILIZATION TREATMENTS ON SOME CORN SILAGE QUALITY PARAMETERS

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ABSTRACT: This research was conducted to determine the effects of different cultivars (PR 31Y43, OSSK-644 and Lacasta) and fertilizer treatments (organic, inorganic, ½ organic + ½ inorganic) on some corn silage quality parameters in the years 2011 and 2012 under the ecological conditions of Eskipazar-Karabuk. The fertilizer treatments were statistically significant on silage dry matter and dry stem ratio values in the second research year and highest values were obtained from inorganic and ½ organic + ½ inorganic fertilizer treatments. While the highest fresh ear ratio values were obtained from Lacasta cultivar in both research years, highest dry leaf ratio values were obtained from PR 31Y43 and Lacasta cultivars in the second research year. High flieg scores obtained from each of the fertilization treatments and corn cultivars in the first and second research year. When we consider the negative effects of inorganic fertilizers on human and environmental health, organic fertilizer treatments come into prominence. Each of the corn cultivars would be preferable due to high flieg scores.
Keywords: Chemical fertilizer, poultry manure, corn cultivars, silage quality

FARKLI ÇEŞİT VE GÜBRE UYGULAMALARININ BAZI MISIR SİLAJI KALİTE PARAMETRELERİ ÜZERİNE ETKİLERİ

ÖZET: Bu araştırma farklı çeşit (PR 31Y43, OSSK-644 ve Lacasta) ve gübre uygulamalarının (organik, inorganik, ½ organik + ½ inorganik) bazı mısır silajı kalite parametreleri üzerine etkilerini belirlemek için Eskipazar-Karabuk ekolojik koşullarında 2011 ve 2012 yıllarında yürütülmüştür. Araştırmanın ikinci yılında gübre uygulamaları silaj kuru maddesi ve kuru sap oranları üzerine istatistiki olarak etkili olmuştur ve en yüksek değerler inorganik ve ½ organik + ½ inorganik gübre uygulamalarından elde edilmiştir. Her iki araştırma yılında en yüksek taze koçan oranı değerleri Lacasta çeşidinden elde edilirken, ilk araştırma yılında en yüksek kuru yaprak oranı değerleri PR 31Y43 ve Lacasta çeşitlerinden elde edilmiştir. Birinci ve ikinci araştırma yılında çeşit ve gübre uygulamalarının herbirinden yüksek flieg puanları elde edilmiştir. İnorganik gübrelerin insan ve çevre sağlığı üzerine olumsuz etkileri düşünüldüğünde, organik gübre uygulamaları ön plana çıkmaktadır. Çeşitlerin her biri yüksek flieg puanları sebebiyle tavsiye edilebilir niteliktedir.
Anahtar Sözcükler: Kimyasal gübre, tavuk gübresi, mısır çeşitleri, silaj kalitesi

1. INTRODUCTION

The corn silage is accepted as a semi concentrated feed due to its high value of energy and this high energy is the result of the fact that about 50% of the dry matter of this crop is consist of grains. This characteristic makes the corn silage superior than the silages of other plants and in addition to this the concentrate feed requirement decreases by 33-50% in the animals which are fed with corn silage (Sade and Soylu, 2008). Corn is the most important plant grown for silage making both in our country and in the worldwide (Turgut, 2002). Alcicek and Ozkan (1997) stated that the most important principle for determination of silo feed quality was the flieg score obtained as a result of the chemical evaluation which is made according to the appearance recognized by sense organs and according to the silo acids, but they also told that the dry matter and pH content of the silo feed were also important for this determination. Using of suitable corn cultivars in corn silage production is highly important for producing high quality feed (Iptas and Acar, 2006). The yield and the quality of corn silage is remarkably related with genotype as well as the factors such as climate and soil conditions, altitude, planting time, plant density, irrigation and harvesting time (Cusicanqui and Lauer, 1999).

Research has proved the negative effects of chemical fertilizers on our health. Whereas, the organic fertilizers do not excessive change the nitrate content in the plants compared to the plants those treatment no chemical fertilizer (Anastasios et al., 2007; Nasım et al., 2012). In recent years the import rate of chemical fertilizers in Turkey increased to 46% (Eraslan et al., 2010). Approximately 65% of agricultural soils of Turkey have low organic material content. In fact, the organic matter of the soil is one of the most important factors that limit our agricultural production. For this reason, the treatments of organic materials such as farm manure, compost and green manure is highly required (Kacar, 1994). For these reasons, animal manures should be transformed into organic fertilizers to be used in agriculture before

losing its nutrients rather polluting the environment and disturbance the health. It is assumed that the treatment of poultry manure in a diluted form through drip irrigation system will provide treatment easing and efficiency.

No scientific research has been made before in Eskipazar-Karabuk ecological condition about the corn silage. The determination of effects of different cultivars and fertilizer treatments on corn silage quality parameters was targeted in this research.

2. MATERIALS AND METHODS

The research was conducted at the research fields of Eskipazar Vocational School in the years 2011 and 2012 under the ecological conditions of the district of Eskipazar in the province of Karabük, Turkey. Three different (PR 31Y43, OSSK-644, Lacasta) hybrid corn cultivars (*Zea mays* L. *indentata* S.) were used as materials in this research. Three different fertilizer treatments were applied (organic, inorganic, ½ organic + ½ inorganic) to these cultivars. The poultry manure named *Organica* of *Keskinoglu* company which was pelletized after fermentation was used in organic fertilizer treatments while composed fertilizer 13.24.12.10.1.1 (13% N, 24% P_2O_5, 12% K_2O, 10% SO_3, 1% Zn, 1% Fe) was applied as base fertilizer and ammonium nitrate (33% N) was used as top-dressing fertilizer in inorganic fertilizer treatments. Drip irrigation method was used in irrigation which the system consist of hydro PCND driplines of the John Deere Company having 16 mm diameter emitter with a flow rate 2.35 lt h^{-1} which are emitter spacing 50 cm.

The experimental design was a randomized complete block in a split plot arrangement with three replications. The fertilizer treatments (organic, inorganic, ½ organic + ½ inorganic) were placed randomly on the main plots and the cultivars (PR 31Y43, OSSK-644, Lacasta) were placed randomly on the split plots. The split plots size was 2.8 by 5 m with four rows per plot. The plant density were arranged to be 70x12 cm (119040 plant ha^{-1}) in all plots.

The planting was made by hand on 25th of May in the first year of the research and on 10th of May in the second year of the research. Two seeds were sown in each plant densities and thinned by hand after emergence. After the plants are emerged and the rows became clear, the first hoeing was made when the plant was 4-5 leafed and driplines were placed to the plots. The driplines were placed 1.4 m apart and each dripline was centered between two corn rows spaced 70 cm. The water used in the research was drinkable and was classified as low sodium and medium salty according to the examinations. A transition climate between the Black Sea and continental climate is seen in Eskipazar district where the research was carried out. Some of the climate data recorded in Eskipazar district during the corn growing season of the years 2011-2012 when the research was carried out, and the long term means of these data (1985-2006) were given in Table 1. From the examination of Table 1, it can be seen that the total rain, temperature and relative humidity means in the research years of 2011 and 2012, have been close to the long term means. Soil samples were taken from 0-30 cm depths and analysed in order to determine the physical and chemical properties of the experimental soils. The analysis results of the soil samples were given in Table 2. As seen from this table, the soils are clay-loam textured and the organic matter content is low (1.49%).

TDR (time domain reflectometry) device was used for measurement of the soil moisture for determining the irrigation program during the research. The irrigation was started when the consumption of 30% readily available soil moisture and the water was given from the system by calculating the water amount in a manner to bring 25 cm soil profile to the field capacity in the first periods and 50 cm soil profile to the field capacity after the stem elongation period.

When the plants grown to a height about 40 cm, secondary hoeing were made. Three different fertilization treatments (organic, inorganic, ½ organic + ½ inorganic) were applied to all cultivars. The total N dose of the fertilizer treatments were determined as 3 g plant $^{-1}$. Composed fertilizer 13.24.12.10.1.1 (13% N, 24% P_2O_5, 12% K_2O, 10% SO_3, 1% Zn, 1% Fe) was applied as base fertilizer and ammonium nitrate (33% N) was used as top-dressing fertilizer in inorganic fertilizer treatment. A part of the nitrogen, the whole of the phosphorus and the potassium (0.75 g plant $^{-1}$ N, 1.4 g plant $^{-1}$ P_2O_5, 0.7 g plant $^{-1}$ K_2O) were

Table 1. Climatic data of the research location in the years 2011 and 2012 with the long term means (1985-2006) at Eskipazar, Turkey

Months	Precipitation (mm)			Mean Temperature (°C)			Mean Relative Humidity (%)		
	2011	2012	Long term	2011	2012	Long term	2011	2012	Long
May	68.4	68.2	57.1	13.4	15.4	14.3	73.9	66.7	60.2
June	54.8	21.8	54.8	16.9	20.2	17.9	72.3	58.7	60.8
July	8.2	51.4	24.8	21.6	22.6	20.9	63.1	57.7	55.4
August	17.0	48.0	22.9	19.9	19.9	21.1	62.0	59.9	53.9
September	4.4	6.0	21.6	17.1	18.7	16.3	57.4	54.7	57.5
Total/Mean	152.8	195.4	181.2	17.8	19.4	18.1	65.7	59.5	57.6

Table 2. Physical and chemical soil properties of the research location at Eskipazar, Turkey

Soil properties	
Sand (%)	38.0
Silt (%)	20.0
Clay (%)	42.0
Texture class	Clay-Loam
Total N (kg ha^{-1})	0.34
P_2O_5 (kg ha^{-1})	23.60
K_2O (kg ha^{-1})	170.10
pH	7.60
Salt (%)	0.04
Lime (%)	37.59
Field capacity (%), (v	26.32
Wilting point (%), (v	16.25
Bulk density (g cm^{3-}	1.23
Organic matter (%)	1.49

given as the base fertilizer on the plots where inorganic fertilizing treatment was made. The rest of the nitrogen (2.25 g plant $^{-1}$) were given with each irrigation in the form of ammonium nitrate (33% N). In organic fertilizer treatments, 5 units of water were added to the 1 unit of pelleted poultry manure and waited for 2 days then filtered through 200 mesh filter and then the poultry manure was applied in each irrigation through drip irrigation system (Table 3).

In organic fertilizer treatments 54 kg of diluted poultry manure solutions were applied in each irrigation and 3 g plant $^{-1}$ N, 0.24 g plant $^{-1}$ P_2O_5, 0.25 g plant $^{-1}$ K_2O were given in total. In ½ organic + ½ inorganic fertilizer treatments half of the N dose (1.5 g plant $^{-1}$) were provided from the poultry manure and the other half (1.5 g plant $^{-1}$) were provided from inorganic fertilizers. In this treatment 3 g plant $^{-1}$ N, 0.82 g plant $^{-1}$ P_2O_5, 0.47 g plant $^{-1}$ K_2O was given in total.

After removing border effects, two center rows of each split plot were harvested. The harvesting was made at milk-line was between 50 and 75%. The plant based measurements were made on five plants randomly selected from two center rows of each split plot. Then the plants were made ensilaged with machines and packaged. As for the package material, 57x75 cm sized, 80 micron thick white sacs used that produced from 20% virgin and 80% recycling low density polyethylene. The silage based analyses were made after a fermentation period of 75 days. Silage quality class can be determined through a regression equation using the relationship between the pH value and dry matter content of silage (Geren, 2001).

Flieg Score: [220 + 2 x (silage dry matter (%) - 15)] – (40 x silage pH value)

The Flieg score obtained from the above equation gives important clues about the quality of silage according to the criteria given in Table 4.

Table 4. Flieg scores and silage quality classes that are calculated with dry matter and pH values

Flieg scores	Silage quality classes
0-20	Poor
21-40	Low
41-60	Medium
61-80	Good
81-100	Well

The dry matter (%), pH, flieg score, silage quality class, fresh ear ratio (%), dry leaf, ear and stem ratios (%) were examined in these analyses (Anonymous, 2010).

All data were analyzed using analysis of variance according to experimental design of randomized complete block in a split plot. The differences among the means were compared with LSD test when the F test was significant (Mstat-C, 1980).

3. RESULTS

3.1. Silage Dry Matter, Silage pH, Flieg Score and Silage Quality Class

The silage dry matter values between the fertilizer treatments were statistically significant in the second research year ($P<0.05$). The highest silage dry matter

Table 3. Some properties of pelleted and diluted poultry manure used in research (2011-2012)

Pelleted poultry manure		Diluted poultry manure (1 5^{-1})	
Total N (%)	2.30	Total N (%)	0.42
P_2O_5 (%)	5.86	P (ppm)	343.50
K_2O (%)	3.31	K (ppm)	350.82
Organic matter (%)	61.40	Organic matter (%)	2.07

Table 5. Effects of fertilization and cultivars on silage dry matter (%), silage pH, flieg score and silage quality class

Fertilization (F)	Cultivars (C)	Silage dry matter (%)		Silage pH		Flieg score		Silage quality class	
		2011	2012	2011	2012	2011	2012	2011	2012
Organic	PR 31Y43	28.3	29.4	3.97	3.89	87.6	93.1	Well	Well
	OSSK-644	28.1	28.9	4.02	3.89	85.2	92.2	Well	Well
	Lacasta	29.8	31.9	4.00	3.99	89.8	94.3	Well	Well
Inorganic	PR 31Y43	28.4	32.2	4.04	3.99	85.1	95.0	Well	Well
	OSSK-644	34.7	34.3	4.11	4.09	95.0	95.1	Well	Well
	Lacasta	31.7	31.7	4.14	3.98	87.7	94.3	Well	Well
O+I	PR 31Y43	28.3	29.5	4.16	4.01	80.3	88.7	Well	Well
	OSSK-644	30.6	31.0	4.18	3.88	84.1	96.8	Well	Well
	Lacasta	29.4	32.7	4.01	4.04	88.3	93.9	Well	Well
F Average	Organic	28.7	30.1 b	4.00	3.92	87.5	93.2	Well	Well
	Inorganic	31.6	32.7 a	4.10	4.02	89.3	94.8	Well	Well
	O+I	29.4	31.1 ab	4.12	3.98	84.2	93.1	Well	Well
LSD		ns	1.96*	ns	ns	ns	ns	ns	ns
C Average	PR 31Y43	28.3	30.4	4.06	3.96	84.3	92.3	Well	Well
	OSSK-644	31.1	31.4	4.10	3.95	88.1	94.7	Well	Well
	Lacasta	30.3	32.1	4.05	4.00	88.6	94.2	Well	Well
LSD		ns	ns	ns	ns	ns	ns	ns	ns
FXC int.	LSD	ns	ns	ns	ns	ns	ns	ns	ns

*, **significant at 0.05 and 0.01 probability level; ns: not significant

was obtained from inorganic and ½ organic + ½ inorganic (32.7% and 31.1% respectively) fertilizer treatments and taken place in the first group (a and ab) (Table 5). No statistical difference was found between silage pH, flieg score and silage quality class values obtained in both two research years (Table 5).

3.2. Fresh Ear Ratio, Dry Leaf Ratio, Dry Ear Ratio and Dry Stem Ratio

The fresh ear ratio values between the cultivars in two research years were statistically significant ($P<0.01$). The highest fresh ear ratio was obtained from Lacasta cultivar (45.1%, 44.5% respectively) and taken place in the first group (a) (Table 6). In the first research year the dry leaf ratios between the cultivars were statistically significant ($P<0.05$). The highest dry leaf ratio was obtained from PR 31Y43 and Lacasta hybrid corn cultivars (16.8% and 15.4%) and taken place in the first group (a and ab) (Table 6). No statistical difference was found between the dry ear ratio values obtained in both research years (Table 6). In the second research year, the dry stem ratio values obtained from the fertilizer treatments were statistically significant ($P<0.01$). The highest dry stem ratio was obtained from organic and ½ organic + ½ inorganic (32.6 and 30.7) fertilizer treatments and took place in the first group (a) (Table 6).

4. DISCUSSION

The fertilizer treatments were statistically significant on the silage dry matter and dry stem in the second research year. The highest values were obtained from inorganic and ½ organic + ½ inorganic fertilizer treatments (Table 5 and 6). The results obtained from many researches, that are made on the effects of organic, inorganic and ½ organic + ½ inorganic fertilizer treatments on the silage quality parameters are supporting our findings (Ibeawuchi et al., 2007; Lanyasunya et al., 2007; Fateh et al., 2009; Nazlı, 2011; Yolcu, 2011; Nasım et al., 2012) while some researches provide different results (Sleugh et al., 2006; Tavassoli et al., 2010; Ahmad et al., 2011). The similarities and differences in the research results regarding the fertilizer treatments may be due to the ecological conditions and the differences and similarities of the genetics of the cultivars used in these researches.

The corn cultivars were statistically significant on the fresh ear ratio in both research years. The cultivars were statistically significant on dry leaf ratio in the first research year. In both research years the highest fresh ear ratio values were obtained from Lacasta cultivar. In the first research year, the highest dry leaf ratios were obtained from Lacasta and PR 31Y43 cultivars. (Table 5 and 6). The findings obtained in our research provided similar results with most of the previous researches made for determination of the silage quality parameters of the corn cultivars (Geren, 2001; Darby and Lauer, 2002; Azizi and Hajibabaei, 2012; Oz et al., 2012; Ozata et al., 2012) but also provided different results with other

Table 6. Effects of fertilization and cultivars on fresh ear (%), dry leaf ratio (%), dry ear ratio (%) and dry stem ratio (%)

Fertilization (F)	Cultivars (C)	Fresh ear ratio (%)		Dry leaf ratio (%)		Dry ear ratio (%)		Dry stem ratio (%)	
		2011	2012	2011	2012	2011	2012	2011	2012
Organic	PR 31Y43	38.7	39.4	18.0	16.9	47.4	54.4	34.7	28.7
	OSSK-644	37.6	35.8	14.6	15.7	51.1	49.7	34.3	34.5
	Lacasta	43.4	42.2	16.1	16.1	52.2	49.4	31.7	34.5
Inorganic	PR 31Y43	42.4	39.9	16.0	17.2	53.6	54.6	30.4	28.3
	OSSK-644	40.8	41.9	11.8	14.5	55.5	59.5	32.7	26.0
	Lacasta	45.6	46.8	14.0	14.7	57.9	60.0	28.1	25.3
O+I	PR 31Y43	41.4	39.1	16.5	16.7	54.6	52.5	29.0	30.7
	OSSK-644	39.7	39.1	15.5	14.8	51.0	53.7	33.5	31.5
	Lacasta	46.3	44.4	16.0	17.1	54.7	53.0	29.4	29.9
F Average	Organic	39.9	39.1	16.2	16.2	50.2	51.2	33.6	32.6 a
	Inorganic	42.9	42.9	13.9	15.5	55.7	58.0	30.4	26.5
	O+I	42.5	40.9	16.0	16.2	53.4	53.1	30.6	30.7 a
LSD		ns	ns	ns	ns	ns	ns	ns	3.88*
C Average	PR 31Y43	40.8 b	39.5 b	16.8 a	16.9	51.9	53.8	31.4	29.2
	OSSK-644	39.4 b	38.9 b	14.0 b	15.0	52.5	54.3	33.5	30.7
	Lacasta	45.1 a	44.5 a	15.4 ab	16.0	54.9	54.1	29.7	29.9
LSD		2.99**	2.14**	2.19*	ns	ns	ns	ns	ns
FXC int.	LSD	ns	ns	ns	ns	ns	ns	ns	ns

*, **significant at 0.05 and 0.01 probability level; ns: not significant

researches (Akdeniz et al., 2004; Gencturk, 2007; Erdal et al., 2009). The differences and similarities between the results of these researches regarding the cultivars may be due to the differences and similarities of the ecological conditions of the places where the researches were carried out as well as due to the cultural conditions such as planting densities, irrigation and fertilizer treatments.

When we consider the negative effects of inorganic fertilizers on human and environmental health, organic fertilizer treatments come into prominence. Each of the corn cultivars would be preferable due to high flieg scores.

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