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The Effects of Different Nitrogen Doses on Silage Yield of Maize (*Zea mays* L.) Cultivars

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Absract: This study was carried out in the experimental field in Salihli district of Manisa province in 2015, aiming to determine the effects of different nitrogen doses (0, 4, 8, 12, 16, 20, and 24 kg N da^{-1}) on silage yield and quality characteristics of maize cultivars (C-955, TK-6063, and Colosseus). The field experiment was designed in a randomized complete block (RCBD) with three replications. The effects of nitrogen doses on the silage yield components showed statistically significant differences. According to the results, the effects of different nitrogen doses on herbage yield (kg da^{-1}), plant height, number of leaves, stem diameter, and ear ratio (%) were statistically significant. However, the effects of different nitrogen doses on the leaf ratio (%) and stem ratio (%) were not found statistically significant. The average value of herbage yield was between 7406.0 and 8880.1 kg da^{-1}; the plant height of maize genotypes varied between 248.2 and 299.4 cm; the number of leaves per plant was between 11.4 and 14.3; stem diameter varied between 2.4 and 2.7 cm; ear ratio was between 27.1% and 31.0%.. Among the nitrogen doses used in the experiment, the optimum nitrogen dose in terms of silage yield was determined as 20 kg da^{-1}.

Keywords: Herbage yield, stem diameter, ear ratio, leaf ratio, stem ratio

Farklı Azot Dozlarının Mısır (*Zea mays* L.) Çeşitlerinin Silaj Verimi Üzerine Etkileri

Öz: Bu çalışma, Manisa ili Salihli ilçesi ekolojik koşullarında üç farklı silajlık mısır çeşidi ile (C-955, TK-6063 ve Kolosseus) yedi farklı azot dozunun (0, 4, 8, 12, 16, 20 ve 24 kg N da^{-1}) mısır çeşitlerinin silaj verimi ve kalitesi üzerine etkilerini belirlemek için 2015 yılında şahsa ait arazide üç tekerrürlü olarak "Tesadüf Blokları Deneme Desenine" göre yürütülmüştür. Araştırmada azot dozlarının silaj verimi unsurları üzerine etkileri istatistiksel açıdan önemli farklılıklar göstermiştir. Araştırma sonuçlarına göre mısır çeşitlerinin ortalama; yeşil ot verimi, bitki boyu, yaprak sayısı, sap çapı, yeşil otta koçan yüzdesi üzerine azot dozlarının etkisi istatistiksel olarak önemli bulunmuş, bununla birlikte mısır çeşitlerinin ortalama; yeşil otta yaprak yüzdesi ve yeşil otta sap yüzdesi üzerine azot dozlarının etkisi önemli bulunmamıştır. Azot dozlarının önemli etki ettiği silaj verimi unsurları; yeşil ot verimi 7406.0-8880.1 kg da^{-1}, bitki boyu 248.2 -299.4 cm, yaprak sayısı 11.4-14.3 adet, sap çapı 2.4-2.7 cm, yeşil otta koçan yüzdesi %27.1-%31.0 arasında bulunmuştur. Denemede kullanılan azot dozları arasında silaj verimi açısından en uygun azot dozu 20 kg da^{-1} olarak tespit edilmiştir.

Anahtar Kelimeler: Yeşil ot verimi, sap çapı, koçan oranı, yaprak oranı, sap oranı

1. Introduction

In addition to being an industrial raw material, the maize plant is an important product used in human and animal nutrition. Of the maize produced in the world, 35% is used in human nutrition, and 65% is used as animal feed. The green parts and grains of maize can be used in animal feeding and as silage. The preservation of green forage materials in maize plants is possible by making silage (Kırtok, 1998; Yolcu and Tan, 2008; Kuşaksız, 2010).

The maize plant has spread widely horizontally and vertically on the earth due to its cultivar richness, ability to adapt to environmental conditions, and high yield potential. In Turkey, maize ranks third after wheat and barley in terms of cultivation and production and first among all cereals in terms of yield. In our country, the production of silage maize and green forage in recent years has enabled the land where it is cultivated to increase a little more.

In Turkey, maize is cultivated on a total area of 639.084 hectares and has a production of 5.9 million tons (Tuik, 2017).

Maize attracts attention with its features such as creating large amounts of green parts per unit area, being very suitable for silage preparation, short growing period, being prepared as silage without additives, high nutritional value and palatability, richness in starch, and high digestibility(Yıldırım and Baytekin, 2003).

The lack of quality roughage, which is one of the main reasons for low yield in animal production and which results in the inability of our people to consume sufficient animal protein, is due to the problems of the sectors that provide quality forage in the animal production of Turkey(Avcıoğlu et al., 2000; Alçiçek, 2001). Therefore, the solution to the forage problems of our livestock sector should be sought not only in intense/concentrated forage sources but also the insufficiency of our quality roughage sources, and solutions should be created by examining the structural and economic features of our forage crop agriculture. Forage crop agriculture, which takes a very important place in agricultural production, is the insurance of plant and animal production and is the most important way of continuous and safe roughage production (Açıkgöz,2001; Açıkgöz et al., 2005).

Nitrogen has many functions and plays a key role in plant metabolism. This element is involved in different metabolic events and protein synthesis. Most of the cultivated soils provide plant growth without fertilization. However, if a high yield is desired, nutrients in mineral form should be applied to the soil in the form of fertilization. More than 95% of the nitrogen in the soil is in organic form. This organic form cannot be taken up by plants, and it must undergo a mineralization process. In other words, it needs to be transformed from organic form to mineral nitrogen through decomposition reactions, called aminization and ammonification. Insufficient nitrogen supply emerges as a limiting factor in maize cultivation. Nitrogen is needed from the early stages of plant development and participates in protein and chlorophyll biosynthesis in plant metabolism. Generally, nitrogen is found in the soil solution in the form of nitrate or ammonium. However, plants are physiologically more responsive to nitrate feed. There are many differences between plant species regarding the efficiency of nitrogen utilization (Kacar and Katkat 2009; Demari et al., 2016).

The aim of this study is to determine the effects of different nitrogen and cultivars on the silage yield components in the maize plant, which has significant potential in animal nutrition.

2. Materials and Methods

The study was conducted in a producer's field in Manisa province, Salihli district, Kapancı neighborhood, where the maize plant was grown as the first crop in 2015. The research site is approximately 111 m above sea level. The climate data of the research site were obtained from the Manisa Meteorology Directorate (Anonymous, 2015). The air temperature, total precipitation, relative humidity, and monthly averages of the year (2015) when the experiment was conducted and multi-year (1995-2015) averages are presented in Table 1.

To determine the soil properties of the research site, soil samples taken from a 0-30 cm depth of the profile opened properly in the field were subjected to physical and chemical analysis in the Chamber of Agriculture Analysis Laboratory in Salihli, and the results are shown in Table 2.

As a result of the analysis conducted, in the sample with soil pH was slightly alkaline soil reaction, the total salt soluble in water values indicated that there wouldn't problem in terms of salinity in plant cultivation. The soil was limy, and the texture of the soil was loamy

Table 1. *Climate Conditions of Experimental Area (2015 and Long term)*
Çizelge 1. *Deneme alanına ait iklim verileri (2015 ve Uzun yıllar)*

Months	2015		
	Average Temprature (°C)	Monthly Total Precipitation (mm)	Relative Humudity (%)
January	6.4	117.4	76.4
February	8.0	78.2	70.8
March	10.7	47.4	72.9
April	13.9	41.5	55.6
May	21.4	32.3	52.1
June	23.2	43.1	59.6
July	28.4	4.2	45.8
August	28.5	18.6	49.7
September	25.7	11.6	55.8
October	18.6	24.4	66.4
November	13.5	45.0	66.5
December	5.5	0.8	73.7
Mean	16.98		62.11
Total		464.5	
	Long term (1995-2015)		
January	6.6	57.1	74.4
February	7.9	59.2	69.9
March	10.7	44.4	64.8
April	15.3	42.4	61.3
May	21.2	24.8	54.1
June	26.0	12.9	48.5
July	28.6	6.1	47.7
August	28.1	5.2	50.8
September	23.2	19.5	55.7
October	17.4	26.8	64.3
November	12.0	52.2	70.6
December	8.1	57.9	75.0
Mean	17.09	34.04	61.43
Total		408.5	

Table 2. Soil properties of the experimetal field
Çizelge 2. *Deneme tarlasına ait toprak özellikleri*

Properties	**Sample depth (cm)**
	0-30 cm
Saturation with water (Dew)	42.0
Soil texture (Class)	Loamy
Soil pH	7.94
Lime ($CaCO_3$) (%)	3.60
Available phosphorus (mg kg^{-1})	0.11
Available potassium (kg da^{-1})	52.0
Organic matter (%)	0.17
Soluble total salt (%)	0.03
Total nitrogen (%)	0.01

The organic matter findings demonstrated that the organic matter content in this soil was very low, the total nitrogen was poor, the available phosphorus level was very low, and the available potassium level was sufficient. Soil properties couldn't play a limiting role in terms of maize cultivation.

Table 3. Maize Cultivars Used as Research Materials
Çizelge 3. *Araştırma Materyali Olarak Kullanılan Mısır Çeşitleri*

Cultivar Name	**Supplier Company**	**FAO Group**
C-955	DEKALB Ltd. Şti.	800
TK-6063	TAREKS A.Ş.	650
Colosseus	KWS TÜRK TARIM TİC. A.Ş.	680

The study was carried out in three replications in a randomized complete block design in accordance with the factorial trial design by placing the first factor as nitrogen doses (0-4-8-12-16-20-24 kg N da^{-1}) and the second factor as cultivars (C-955, TK-6063, Colosseus).

In each replication, one plot consisted of 5 rows, the inter-row spacing in the plot was 65 cm, the intra-row spacing was 20 cm, the plot length was 5 m, and the plot dimensions were 5 m x 3.25 m = 16.25 m^2 (Gross). In the experiment consisting of 63 plots in total, a distance of 1 meter was left between the blocks. Seeds were sown manually to a depth of 5-6 cm on 20 April 2015, with two seeds in each pit.

In the experiment, Triple Super Phosphate in the form of 8 kg P_2O_5 da^{-1} and Potassium Sulphate in the form of 8 kg K_2O da^{-1} were mixed into the soil as bottom fertilizers at planting. Nitrogen doses (0-4-8-12-16-20-24 kg N da^{-1}), which were pre-adjusted according to the experimental plots and varied according to the plots, were given to the plots in proportion to their measurements. Half of the nitrogenous fertilizer was given to the band in the form of ammonium sulfate (21%) right after emergence, and the remaining half was given to the band as top fertilizer when the maize plants were 40-50 cm tall. When the plants reached 8-10 cm after emergence, the thinning procedure was applied to ensure equal plant density in the plots. The drip irrigation system was installed on 2 May 2015, and the emerging plants were started to be irrigated with drippers with a drip flow of 1.6 lt hour $^{-1}$ in the periods of need. When the plants reached 15-20 cm in height and 40-50 cm, weed control and earthing up processes were carried out by hoeing(Ozaslan, 2019).

Harvest stage was determined considering the suggestion of (Geren, 2000; Kuşaksız and Kuşaksız, 2008) and it was practiced on two-third milking stage. Ten plants were harvested from each plot, whose ears reached the stage of sweetening and the 1st and 5th rows, representing the edge effects, were not harvested.

The data obtained in this study were evaluated statistically according to the studies of Steel and Torrie (1980) and Yıldırım and Kuşaksız (2002), using MSTAT-C (Freed et al., 1989) statistical packaged software on the computer. Each characteristic measured according to the randomized complete block design was subjected to variance analysis in accordance with this design, the significance of variances was checked with the F-test, and multiple comparisons were made according to the LSD test.

3. Results and Discussions

When Table 4 is examined, the effect of different nitrogen doses on herbage yield of maize cultivars was found to be statistically significant at the level of 5%, and their effect on plant height, number of leaves, stem diameter, and ear ratio was found to be statistically significant at the level of 1%, while it was not found to be significant for the characteristics of leaf ratio and stem ratio.

While there was no statistical significance for the characteristics of herbage yield and leaf ratio among maize cultivars, 1% significance was determined for other characteristics.

Nitrogen*Cultivar interaction was found to be significant at the level of 5% for plant height and ear ratio characteristics, but not for other characteristics.

Table 4. Mean Square Values and Variance Analysis Results for Different Characteristics of Maize Cultivars at Different Nitrogen Doses

Çizelge 4. *Farklı Azot Dozlarında Silajlık Mısır Çeşitlerinin Farklı Özelliklerine ait Varyans Analizi ve Kareler Ortalaması Değerleri*

Sources of Variation	**SD**	**Herbage Yield**	**Plant Height**	**Number of Leaves**	**Stem Diameter**	**Ear Ratio**	**Leaf Ratio**	**Stem Ratio**
Replication	2	6011621.39 **	1633.4 NS	0.39 NS	0.001 NS	9.17 NS	102.85 **	54.49 **
Nitrogen	6	2509026.95 *	2681.5 **	10.12 **	0.10 **	16.51 **	9.38 NS	7.77 NS
Cultivar	2	854229.58 NS	9240.7 **	1.92 **	0.12 **	143.70 **	2.85 NS	152.45 **
Nit.Cul.	12	247749.08 NS	425.8 *	0.14 NS	0.01 NS	9.29 *	8.55 NS	11.27 NS
Error	40	859993.61	698.9	0.26	0.01	4.38	7.63	9.41
General	62	1067074.15	1143.6	1.25	0.02	11.16	10.89	15.68
C.V.		12.91	11.84	8.31	6.33	11.48	12.45	8.91

*: P< 0.05, ** : P<0.01, NS: Not significant

When the effect of nitrogen doses on herbage yield was examined in Table 5, it was observed that the highest value was obtained with 8880.1 kg at a dose of 20 kg N da $^{-1}$, and the lowest value was obtained with 7406.0 kg at a dose of 0 kg N da $^{-1}$.

In other studies on herbage yield of maize cultivars at different nitrogen doses, Yılmaz and Sağlamtimur (1996) stated in the study they conducted in Adana that the herbage yield was the lowest with 5580.59 kg at a dose of 0 kg N da $^{-1}$ and the highest with 6172.59 kg at a dose of 18 kg N da $^{-1}$ as the average of two years. In the study carried out in Van, Yılmaz et al. (2001) determined that the herbage yield was the lowest with 4776.1 kg at a dose of 0 kg N da $^{-1}$ and the highest with 6755.4 at a dose of 24 kg N da $^{-1}$ as the average of two years. In the study performed in Diyarbakır, Baytekin et al. (2004) demonstrated that the herbage yield was the lowest with 5412.34 kg at a dose of 0 kg N da^{-1} and the highest with 6855.69 kg at a dose of 20 kg N da^{-1}. In the study conducted in Bursa, Çelik et al. (2008) showed that the herbage yield was the lowest with 4889.3 kg at a dose of 0 kg N da^{-1} and the highest with 7477.6 kg at a dose of 40 kg N da^{-1} as the average of two years. In the study conducted in Bursa, Karasu et al. (2009) found that the herbage yield was the lowest with 8096.5 kg at a dose of 0 kg N da^{-1} and the highest with 9562.5 kg at a dose of 30 kg N da^{-1} as the average of two years. In the study carried out in Van, Çelebi et al. (2010) indicated that the herbage yield was the lowest with 4040.5 kg at a dose of 0 kg N da^{-1} and the highest with 6521.1 kg at a dose of 20 kg N da^{-1} as the average of two years. In the study performed with 15 cultivars in Manisa, Kuşaksız (2010) found the lowest herbage yield as 3902.0 kg and the highest herbage yield as 8245.0 kg at a dose of 20 kg N da^{-1}. In the two-year study conducted in Van, Zorer Çelebi (2010) reported that the herbage yield was the lowest with 4200.0 kg at a dose of 0 kg N da^{-1} and the highest with 6396.8 kg at a dose of 20 kg N da^{-1}. In the study carried out under Erzurum conditions, Tan et al. (2013) stated that the herbage yield was the lowest with 5899.2 kg at a dose of 0 kg N da^{-1} and the highest with 10147.6 kg at a dose of 15 kg N da^{-1}.

According to the results of our study, the highest herbage yield was taken as 8880.1 kg from the dose of 20 kg N da^{-1}. In our study, herbage yield increased up to the nitrogen dose of 20 kg N da^{-1} and then decreased.

The herbage yield values obtained in our study are above the values found by Yılmaz ve Sağlamtimur (1996), Yılmaz et al. (2001), Baytekin et al. (2004), Çelik et al. (2008), Çelebi et al. (2010), Kuşaksız (2010), and Zorer Çelebi (2010). However, they are below the values determined by Karasu et al., (2009); Tan et al., (2013).

The herbage yield values obtained in the experiment may have differed from previous studies due to the cultivar, care technique, climate, and soil characteristics.

Table 5. Effect of Different Nitrogen Doses on Some Characteristics of Maize Cultivars
Çizelge5. *Mısır Çeşitlerinin Bazı Özellikleri Üzerine Farklı Azot Dozlarının Etkisi*

Nitrogen Doses (kg N da^{-1})	**Herbage Yield (kg da^{-1})**	**Plant Height (cm)**	**Number of Leaves (pcs)**	**Stem Diameter (cm)**	**Ear Ratio (%)**	**Leaf Ratio (%)**	**Stem Ratio (%)**
0	7406.0 c	248.2 b	11.4 c	2.4 c	28.5 ab	26.3	45.2
4	7468.8 c	292.2 a	12.5 b	2.6 ab	29.2 ab	26.0	44.8
8	7729.2 bc	287.3 a	14.0 a	2.5 b	30.7 a	25.3	44.0
12	7948.7 bc	286.2 a	13.7 a	2.5 b	28.8 ab	28.2	43.0
16	8177.8 abc	299.4 a	14.0 a	2.6 ab	27.1 b	27.2	45.7
20	8880.1 a	286.5 a	14.3 a	2.7 a	31.0 a	25.5	43.5
24	8394.3 ab	297.8 a	14.1 a	2.6 ab	29.0 ab	26.6	44.4
Mean	8000.7	285.4	13.4	2.6	29.2	26.5	44.4
LSD Value	883.502	33.799	0.656	0.154	3.445	2.632	2.923
Cultivar							
C-955	8222.0	307.9 a	13.8 a	2.5 b	24.2 b	29.0 a	46.8 a
TK-6063	7952.5	266.3 b	13.2 b	2.5 b	32.9 a	25.6 b	41.5 b
Colosseus	7827.4	281.9 b	13.2 b	2.6 a	30.4 a	24.8 b	44.8 a
LSD Value	578.38	22.1	0.43	0.10	4.17	1.22	2.56

The difference between values with different letters in the same column is significant ($P \leq 0.01$).

As seen in Table 4, the effect of different nitrogen doses on the plant heights of maize cultivars was found to be statistically significant at the level of 1%. When the effect of nitrogen doses on plant height was examined, it was observed that the highest value was obtained with 299.4 cm at a dose of 16 kg N da^{-1}, and the lowest value was obtained with 248.2 cm at a dose of 0 kg N da^{-1} (control) (Table 5).

In other studies on the plant height of maize cultivars at different nitrogen doses, Yılmaz et al. (2001) determined in the study carried out in Van that the plant height was the lowest with 226.2 cm at a dose of 0 kg N da^{-1} and the highest with 253.8 cm at a dose of 24 kg N da^{-1}. In their study conducted under Adana conditions, Kara (2006) stated that the plant height was the lowest with 157.0 cm at a dose of 0 kg N da^{-1} and the highest with 290.3 cm at a dose of 27 kg N da^{-1} as the average of two years. Under Bursa conditions, Çelik et al. (2008) obtained the lowest plant height as 257.46 cm at a dose of 0 kg N da^{-1} and the highest plant height as 297.16 cm at a dose of 40 kg N da^{-1} as the average of two years. In the study performed in Van, Çelebi et al. (2010) showed that the plant height was the lowest with 210.7 cm at a dose of 0 kg N da^{-1} and the highest with 226.3 cm at a dose of 20 kg N da^{-1}. Under Manisa Alaşehir conditions, Kuşaksız (2010) obtained the lowest plant height as 190.3 cm and the highest plant height as 238.3 cm at a dose of 20 kg N da^{-1}. Bayram et al. (2012) stated that the plant height was the lowest with 217.4 cm at a dose of 0 kg N da^{-1} and the highest with 248.6 cm at a dose of 30 kg N da^{-1} in the study carried out under Bursa conditions, and the plant height was the lowest with 249.2 cm at a dose of 0 kg N da^{-1} and the highest with 277.3 cm at a dose of 30 kg N da^{-1} under Kocaeli conditions. In the two-year study performed in Van, Zorer Çelebi (2010) demonstrated that the plant height was the lowest with 217.3 cm at a dose of 0 kg N da^{-1} and the highest with 235.6 cm at a dose of 20 kg N da^{-1}. Can and Akman (2014) obtained the lowest plant height as 147.1 cm at a dose of 0 kg N da^{-1} and the highest plant height as 165.9 cm at a dose of 14 kg N da^{-1} in the study carried out under Uşak conditions.

According to the results of our study, although the nitrogen doses of 4, 8, 12, 16, 20, and 24 kg N da^{-1} are in the same group in terms of plant height, the highest plant height was taken as 299.4 cm from the dose of 16 kg N da^{-1}. Nitrogenous fertilizers encourage vegetative growth in the plant, and thus the plant height increases (Kün 1985).

In our study, the plant height increased up to a dose of 16 kg N da^{-1} (299.4 cm) and then decreased. The plant height value obtained in our study was higher than the values found by Yılmaz et al. (2001), Çelebi et al. (2010), Kuşaksız (2010), Zorer Çelebi (2010), Bayram et al. (2013) under Bursa conditions, Can and Akman (2014), and was compatible with the values obtained by Kara (2006), Çelik et al.,(2008), and Bayram et al. (2013) under Kocaeli conditions.

Maize is the most preferred plant in terms of silage due to the high amount of green parts obtained per unit area. The plant height values obtained in the experiment may have differed from previous studies due to the cultivar, care technique, climate and soil characteristics.

As seen in Table 4, the effect of different nitrogen doses on the number of leaves of maize cultivars was found to be statistically significant at the level of 1%. When the effect of nitrogen doses on the number of leaves was examined, it was observed that the highest value was obtained with 14.3 at a dose of 20 kg N da^{-1}, and the lowest value was obtained with 11.4 at a dose of 0 kg N da^{-1} (Table 5).

Among other studies investigating the effects of different nitrogen doses on the number of leaves of maize cultivars, Saruhan and Şireli (2005) obtained the lowest number of leaves as 13.07 at a dose of 0 kg N da^{-1} and the highest number of leaves as 13.45 at a dose of 30 kg N da^{-1} as the average of two years and found the effect of nitrogen doses on the number of leaves insignificant in the study they conducted in Diyarbakır. In the study carried out by Çelik et al. (2008) in Bursa, the lowest number of leaves was 13.70 at a dose of 0 kg N da^{-1}, and the highest number of leaves was 15.5 at a dose of 40 kg N da^{-1} as the average of two years. In the study performed on 15 maize cultivars in Manisa, Kuşaksız (2010) obtained the lowest number of leaves as 10.8 and the highest number of leaves as 14.1 at a dose of 20 kg N da^{-1}.

According to the results of our study, although the nitrogen doses of 8, 12, 16, 20, and 24 kg N da^{-1} are in the same letter group in terms of the number of leaves, the highest number of leaves was taken as 14.3 from the dose of 20 kg N da^{-1}. In the current study, the number of leaves increased up to a dose of 20 kg N da^{-1} (14.3) and then decreased. The value of the number of leaves obtained in our study was higher than the values reported by Çelik et al. (2008) and was compatible with the values found by Kuşaksız (2010). It was not found to be compatible with the study performed by Saruhan and Şireli (2005).

As seen in Table 4, the effect of different nitrogen doses on the stem diameter of maize cultivars was found to be statistically significant at the level of 1%. When the effect of nitrogen doses on stem diameter was examined, it was observed that the highest value was obtained with 2.7 cm at a dose of 20 kg N da^{-1}, and the lowest value was obtained with 2.4 cm at a dose of 0 kg N da^{-1} (Table 5).

In other studies investigating the effect of different nitrogen doses on the stem diameter of maize cultivars, Baytekin et al. (2004) obtained the lowest stem diameter as 1.73 cm at a dose of 0 kg N da^{-1} and the highest stem diameter as 2.04 cm at a dose of 24 kg N da^{-1} as the average of two years in the study they conducted in Diyarbakır. Saruhan and Şireli (2005) showed in the study they carried out in Diyarbakır that the lowest stem diameter was 1.63 cm at a dose of 0 kg N da^{-1} and the highest stem diameter was 2.0 cm at a dose of 30 kg N da^{-1} as the average of two years. In the study performed by Kara (2006) in Adana, the lowest stem diameter was 1.47 cm at a dose of 0 kg N da^{-1}, and the highest stem diameter was 2.12 cm at a dose of 36 kg N da^{-1} as the average of two years. In the study on 15 maize cultivars in Manisa, Kuşaksız (2010) obtained the lowest stem diameter as 2.0 cm and the highest stem diameter as 2.50 cm at a dose of 20 kg N da^{-1}. In the study they conducted in Uşak, Can and Akman (2014) obtained the lowest stem diameter as 1.34 cm at a dose of 0 kg N da^{-1} and the highest stem diameter as 1.41 cm at a dose of 21 kg N da^{-1} and found the effect of nitrogen doses on the stem diameter insignificant.

According to the results of our study, the highest value in terms of the stem diameter was obtained with 2.7 cm from the dose of 20 kg N da^{-1}. In the present study, stem diameter increased up to a dose of 20 kg N da^{-1} (2.7 cm) and then decreased. The stem diameter value obtained in our study is compatible with the studies conducted by Baytekin et al. (2004); Saruhan and Şireli (2005); Kara (2006); and Kuşaksız (2010) is above the values found. It was not found to be compatible with the study performed by Can and Akman (2014).

The stem diameter values obtained in the experiment may have differed from previous studies due to the cultivar, care technique, climate, and soil characteristics.

As can be seen in Table 4, the effect of different nitrogen doses on the ear ratio of maize cultivars was found to be statistically significant at the level of 1%. When the effect of nitrogen doses on the ear ratio was examined, it was observed that the highest value was obtained with 31% at a dose of 20 kg N da^{-1}, and the lowest value was obtained with 27.1% at a dose of 16 kg N da^{-1} (Table 5).

In other studies investigating the effect of different nitrogen doses on the ear ratio of maize cultivars, Yılmaz and Sağlamtimur (1996) obtained the lowest ear ratio as 41.25% at a dose of 0 kg N da^{-1} and the highest ear ratio as 42.25% at a dose of 6 kg N da^{-1} as the average of two years in the study they conducted in Adana. In the study carried out by Yılmaz et al. (2001) in Van, the lowest ear ratio was 34.9% at a dose of 0 kg N da^{-1}, and the highest ear ratio was 39.1% at a dose of 16 kg N da^{-1} as the average of two years. In the study performed in Diyarbakır, Baytekin et al. (2004) reported that the lowest ear ratio was 31.65% at a dose of 12 kg N da^{-1} and the highest ear ratio was 34.98% at a dose of 0 kg N da^{-1}. Çelik et al. (2008) showed in the study they carried out in Bursa that the lowest ear ratio was 14.17% at a dose of 0 kg N da^{-1} and the highest ear ratio was 23.06% at a dose of 40 kg N da^{-1} as the average of two years. In the study conducted by Çelebi et al. (2010) in Van, the lowest ear ratio was obtained as 29.9% at a dose of 0 kg N da^{-1}, and the highest ear ratio was obtained as 34.0% at a dose of 20 kg N da^{-1} as the average of two years. In the two-year study performed in Van, Zorer Çelebi (2010) showed that the lowest ear ratio was 29.6% at a dose of 0 kg N da^{-1}, and the highest ear ratio was 35.5% at a dose of 20 kg N da^{-1}.

According to the results of our study, the highest ear ratio was taken as 31% from the dose of 20 kg N da^{-1}. The ear ratio decreased after a dose of 20 kg N da^{-1}.

The ear ratio values obtained in the present study are lower than the values found by Yılmaz et al. (2001). They are higher than the values determined by Çelik et al. (2008). They were not found to be compatible with the studies conducted by Yılmaz and Sağlamtimur (1996), Baytekin et al. (2004), Çelebi et al. (2010), and Zorer Çelebi (2010).

The ear ratio values obtained in the experiment may have differed from previous studies due to cultivar, care technique, climate, and soil characteristics.

4. Conclusion

According to these results, it is understood that the best and economical dose for the silage yield of silage maize cultivars is 20 kg N da^{-1}. The maize cultivar C-955 stands out as the best cultivar in terms of herbage yield, plant height, number of leaves.

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