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ADAPTABILITY OF SOME NEW MAIZE(Zea mays L.) CULTIVARS FOR SILAGE PRODUCTION AS MAIN CROP IN MEDITERRANEAN ENVIRONMENT

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ABSTRACT

This research was carried out to determine the adaptability cultivars for silage productıon as main crop. The experiment was conducted at Alasehir county of Manisa province in western Turkey in 2006 and 2007. The varieties tested are Varenne, C-955, AG-92150, AG-92149, DKC-6022, MF-714, Tietar, AG-92148, Mitic, DKC-6610, DKC-6842, Ada-523, Goldavid, Doge and Vero. Significant differences were detected among the varieties for plant height, number of green leaves per plant, stem diameter, dry matter content(%), dry matter yield and herbage yield traits. Average plant height of maize genotypes varied between 173.6 and 238.3 cm; number of green leaves per plant between 10.8 and 14.1; stem diameter between 2.0 and 2.5 cm; dry matter (%) between 34.28 and 53.70; dry matter yield between 20.95 and 38.54 t ha^{-1}; herbage yield between 39.02 t ha^{-1} and 82.45 t ha^{-1}. We concluded that C-955, Goldavid, Mitic and AG-92150 cultivars were superior than other cultivars for herbage and dry matter yield traits, respectively.

Key words: Maize cultivars, plant height, dry matter yield, herbage yield

INTRODUCTION

Maize is a warm season cereal, which is commonly cultivated in large areas for seed production. Maize ranks third, following wheat and rice, in the world production of cereal crops and it is the most important nutrient for local populations in middle and south America, Africa and China. It is mostly cultivated in many countries for silage production in last thirty years. Maize is the most important silage crop in the world, because it is the most proper crop for ensiling. It produces abundant amount of green herbage and maize silage has high nutritive value and palatability(Kirtok, 1998; Akdeniz, et.al., 2004; Erdal et al., 2009).

In Turkey, the agricultural area devoted annualy to maize is 593710 hectar which is about 4% of cereal cultivating area and average grain production is 4 274 000 ton per year. Importance of corn production is increasing year by year because of its value for silage production as well as grain production. Maize grain production of Turkey is portioned as follow; about 35% for human nutrient requirement, about 65% for animal feed (Keskin et al., 2005).

Traditional ruminant livestock production in Turkey is based predominantly on animals grazing natural pastures with low nutritive value especially during dry seasons. The nutritive value of the naturel pastures varies according to season. Fodder deficiency exceeds in the colder hilly tracts of the country and much more in the dry land areas where agriculture totally depends on seasonal rainfall. Fodder defiency adversely affects milk, milk products, and meat avaibility in Turkey (Avcioglu,1983; Genckan, 1992; Saglamtimur et al., 1990; Soya et al., 1997; Orak and Iptas, 1999, Kusaksiz and Kusaksiz, 2005; Yolcu and Tan, 2008; Bulut et.al., 2008).

The existing fodder resources are too limited to provide even only half of the maintenance ration for the existing livestock population(Avcioglu,1983; Saglamtimur et al., 1990; Soya et al., 1997; Geren et al., 2008). The strategy for the enhancement of livestock production in the country should be therefore primarily focused on the increasing forage and fodder productivity both quantitatively and qualitatively through introduction of high yielding races in areas where they can relatively perform better under existing climatic conditions. The Aegean region has promising important potential for livestock production. To meet the increasing needs for feed in the region, the best adapted maize cultivars should be selected both as main and second crop. In previous studies; the yield and adaptation of different maize cultivars were investigated and the results varied widely.

Iptaş (1993) found that, plant height of maize genotypes varied from 177.4 to 292.4 cm and herbage yield 38.67 to 82.20 tha^{-1} and dry matter yield 6.93 to 26.44 tha^{-1} and crude protein (%) 6.46 to 8.62 under Tokat conditions.

Konak (1994) reported that, plant height changed between 211.0 to 239.0 cm, and herbage yield 51.84 to 71.92 t ha^{-1} and dry matter (%) 26 to 45 and dry matter yield 16.73 to 24.47 tha^{-1} in maize cultivars grown as a main crop at Menemen-Izmir conditions.

Bilgen et al. (1996) indicated that, herbage yield of maize genotypes varied between 51.91 to 80.99 tha^{-1} and dry matter

(%) 23.2 to 26.3 and dry matter yield 13.65 to 18.79 tha^{-1} and crude protein (%) 6.42 to 9.15 under Menemen conditions.

Yılmaz and Saglamtimur (1996) detected that, plant height changed from 248.1 to 262.1 cm. and herbage yield 55.47 to 60.08 t ha^{-1} and dry matter yield 19.85 to 23.15 tha^{-1} and crude protein (%) 7.52 to 9.59 in maize cultivars grown as a main crop under Cukurova conditions.

Akdemir et al. (1997) reported that plant height changed from 215.0 to 259.0 cm and herbage yield 46.86 to 70.74 t ha^{-1} and dry matter (%) 36.13 to 39.89 and dry matter yield 18.41 to 23.84 t ha^{-1} at Ödemiş- İzmir.

Geren (2000), evaluated six maize genotypes and found significant differences among genotypes for plant height, number of green leaves per plant, stem diameter, dry matter (%), dry matter yield, crude protein and herbage yield. He reported that plant height changed from 193.0 to 218.6 cm, number of green leaves per plant 12.0 to 14.3, stem diameter 2.18 to 2.47 cm, dry matter (%) 23.58 to 25.00, dry matter yield 18.29 to 22.91 t ha^{-1}, crude protein (%) 7.49 to 9.00 and herbage yield 73.35 to 94.14 t ha^{-1} in maize cultivars grown as a main crop at Bornova- İzmir.

Degirmenci (2000) displayed that plant height of maize genotypes varied from 110.5 to 246.0 cm and stem diameter 1.64 to 2.12 cm and number of green leaves per plant 8.1 to 12.7 and dry matter (%) 25.00 to 25.90 and dry matter yield 9.09 to 23.14 t ha^{-1} and crude protein (%) 9.6 to 12.4 and herbage yield 36.18 to 92.38 tha^{-1} in maize cultivars grown as a main crop at Menemen-Izmir.

Avcioglu et al. (2001) found that herbage yield 91.25 to 99.42 tha^{-1} and dry matter yield 23.50 to 25.28 t ha^{-1} under Bornova conditions.

Yilmaz et al. (2003) evaluated 24 maize cultivars in 1998 and found significant differences among genotypes for plant height, stem diameter, dry matter yield and herbage yield. They reported that, plant height changed from 197.9 to 233.2 cm, and stem diameter 1.91 to 2.43 cm, and dry matter yield 21.98 to 26.87 t ha^{-1} and herbage yield 40.00 to 63.05 t ha^{-1} in maize cultivars grown as a second crop under Amik plain conditions of Hatay.

Budak and Soya (2003) evaluated 4 maize cultivars and found significant difference among cultivars for plant height, stem diameter, herbage yield and number of green leaves per plant. They reported that plant height varied from 134.2 – 242.0 cm and stem diameter 1.73-2.14 cm and herbage yield 39..86-86.58 t ha^{-1} and number of green leaves per plant 8.3-13.3 and dry matter (%) 22.5 to 31.7 and dry matter yield 8.97 to 20.48 t ha^{-1} , crude protein(%) 6.69 to 8.91 in maize cultivars grown as second crop at Bornova- İzmir.

Korkut et al (2009) found that plant height of maize genotypes grown as main crop varied from 169.0 to 237.0 cm and stem diameter 1.60 to 2.50 cm and herbage yield 59.52 to 66.67 tha^{-1} at Trakya region.

Oz et al. (2009) evaluated 5 maize cultivars in 2006 and found significant differences among genotypes for plant height and herbage yield. They reported that plant height changed from 275.0 to 338.0 cm, and stem diameter 2.30 to 2.44 cm, and herbage yield 57.55 to 75.26 t ha^{-1} in maize cultivars grown as main crop in Samsun and Konya ecological conditions.

The most important component providing high yield is that to use the best adapted cultivars in any region. Cultivars may show highly different yield performances depending on soil and climatic conditions from one region to another, so the best adaptable cultivars should be determined for any region. Additionaly, one shuld remember that cultivars of different origin may provide higher yield then the domestic cultivars (Saruhan et al. 2007).

The objective of this study was to evaluate the herbage yield potential and some yield components of different new maize (*Zea mays* L.) cultivars under irrigated conditions of Manisa.

MATERIALS AND METHODS

This study was conducted at Alaşehir Vocational School fields in 2006 and 2007. The physical and chemical properties of the surface soil (0-20 cm) are as follows: Texture was sandy clay, pH was 7.8, organic matter content was 1.40 % and P, K, and Ca contents in the upper 20 cm. of soil were 0.21 ppm, 120 ppm. and 8173 ppm, respectively. The monthly rainfall and mean temperature during the study are summarized in Table 1.

Table 1. Average temperature and rainfall in the experimental area in 2006 and 2007 (Anonymous, 2008).

	Average Temperature (ºC)			Rainfall (mm)		
Months	Long Year	2006	2007	Long Year	2006	2007
May	20.4	20.5	21.8	32.9	35.9	24.2
June	25.2	24.6	26.1	12.9	42.4	7.4
July	27.9	26.7	28.4	9.4	13.5	16.2
August	27.3	28.2	27.8	7.0	0.0	0.0

The experiment was designed in a Randomized-Complete-Block Design with three replications. The trial was run at the same field for two years. Each plot consisted of six rows, 8 m long, and 0.65 m apart. The seeds were planted 0.20 m apart in the rows. The total area of each plot was 31.2 m^2 and the harvest area of each plot was 15.6 m^2. Sowing dates were 5 May 2006 and 5 May 2007. Hybrid maize cultivars, Varenne, C-955, AG-92150, AG-92149, DKC-6022, MF-714, Tietar, AG-92148, Mitic, DKC-6610, DKC-6842, Ada-523, Goldavid, Doge and Vero were used as the

crop material in the experiment. These cultivars were obtained from the KWS Turk Seed Trade Company(Doge and Vero), Syngenta Seed Trade Company(Mitic and Goldavid), Agromar Seed Trade Company(Varenne, AG-92150, AG-92149, MF-714, AG-92148) ; Monsanto Seed Trade Company(Tietar, C-955, DKC-6022, DKC-6610, DKC-6842) and Sakarya Agriculture Institute(Ada-523). The full dose of nitrogen (100 kg N ha $^{-1}$), phosphate(100 kg P_2O_5 ha $^{-1}$) and potassium (100 kg. K_2SO_4 ha^{-1}) were applied at sowing. Additional dose of nitrogen (100 kg N ha $^{-1}$) was applied at the stage when the crops were 40-50 cm. Four irrigations were applied each year and weeds were controlled by hoeing. The maize crops were harvested 90 days after sowing. Plant height, number of green leaves per plant and stem diameter traits were measured on ten randomly selected plants in each plot.

Dry matter (%): DM contents of plants were determined by drying the samples at 105 ºC for 24 hours (Geren, 2000).

Herbage yield(t/ ha $^{-1}$): The plants harvested from the soil level were immediately measured and weighed.

Dry matter yield (t/ ha $^{-1}$) was calculated by multiplying herbage yield and dry matter percentage.

All data were analyzed applying the analysis of variance procedures using the MSTAC software package program (Freed et al.,1989). The comparison of the genotype means was made using the Duncan test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Variation analysis showed that cultivars were statistically and significantly different for all traits($P<0.01$). Cultivar x Year interaction effect was found none significant for plant height, number of green leaves per plant, stem diameter, herbage yield and dry matter yield ($P<0.05$). Cultivar x Year interaction effect was found to be significant for dry matter content (Table 2).

Table 2. The F values for the traits measured based on the combined analysis over 2 years

Source	Plant height	Number of green leaves per plant	Stem diameter	Herbage yield	Dry matter content(%)	Dry matter yield
Year	0.61 ^{NS}	0.04 ^{NS}	1.39 ^{NS}	0.09^{NS}	11.86**	0.07^{NS}
Cultivar	6.62 **	14.70 **	3.15 **	5.62**	19.69**	5.33**
C x Year	0.39 ^{NS}	0.10 ^{NS}	0.53 ^{NS}	0.53 ^{NS}	2.01*	0.57 ^{NS}

*, **, indicates significance at 0.05 and 0.01, respectively, NS indicates not significant

Plant height (cm): Plant height was significantly different among maize cultivars in 2006 and 2007 (Table 2). Cultivar C-955 had highest plant height(238.3 cm), while lowest plant height(173.6) was recorded in cultivar DKC-6842 (Table 3). Similar results was also reported by Degirmenci (2000); Budak and Soya (2003) and Korkut et al.(2009).

Number of leaves per plant: The F values(Table 2) indicated that number of leaves per plant were significantly being effected in all cultivars in 2006 and 2007. Cultivar C-955 had the maximum(14.1) number of leaves per plant, while the minimum number of leaves(10.8) per plant were taken from DKC-6842 (Table 3). These findings are in agreement with those of Budak and Soya(2003).

Stem diameter (cm): The combined analysis of variance for 2 years for stem diameter gave significant F value(Table 2). Highest stem diameter value of 2.50 was recorded in cultivar AG-92148 while lowest stem diameter of 2.00 cm was observed in maize cultivar DKC-6842 (Table 3). Similar results have been recorded by Geren(2000); Yılmaz et al.(2003) and Korkut et al.(2009).

Herbage yield (t ha^{-1}) : Herbage yield(t ha^{-1}) was significantly being effected by various cultivars in 2006 ($P<0.05$). However, highly significant $P<0.01$ difference were detected among cultivars for herbage yield (t ha^{-1}) in 2007 (Table 2). Highest herbage yield (82.45 t ha^{-1}) was recorded in cultivar C-955 (Table 3). This variation may be due to the different genetic capacity of the genotypes (Allard, 1999). Similar results were recorded by Iptaş (1993); Konak (1994); Bilgen et al.(1996); Akdemir et al.(1997); Degirmenci (2000); Budak and Soya (2003) and Oz et al.(2009).

Dry matter content (%): Dry matter contents(%) were significantly different in various cultivars in 2006 and 2007. Year and Cultivar x Year interaction effect were found to be significant ($P<0.05$) for dry matter content. Highest dry matter value (54.26 %) was found in cultivar DKC-6842 which is followed by cultivar Tietar(50.76 %). Lowest value was recorded in cultivar AG-92148 as 33.14 % in 2006.

Dry matter yield (t ha^{-1}): Dry matter yield (t ha^{-1}) was significantly different among the maize cultivars in 2006 and 2007. Highest yield (38.54 t ha^{-1}) was recorded in cultivar Mitic which is followed by cultivar AG-92150 with 35.48 t ha^{-1} dry matter yield. Lowest dry matter yield(20.95 t ha^{-1}) was recorded in cultivar DKC-6842. Similar yield values were reported by Konak(1994), Akdemir et al.(1997), Geren(2000), Yılmaz and Saglamtimur (1996), Yılmaz et al.(2003).

Table 3. Means of the traits measured in maize cultivars.

Maize cultivars	Plant height (cm)	Number of green leaves per plant	Stem diameter (cm)	Herbage yield (t ha^{-1})	Dry matter content (%)		Dry matter yield (t ha^{-1})
					2006	**2007**	
Varenne	202.8 abc	12.6 cde	2.49 a	74.41 ab	44.15 e	44.71 cde	33.05 abc
C-955	238.3 a	14.1 a	2.45 a	82.45 a	38.17g	40.64 fg	32.54 abc
AG-92150	205.5 abc	12.3 de	2.24 ab	76.20 ab	46.39 d	46.77 bc	35.48 ab
AG-92149	217.4 ab	12.5 cd	2.10 ab	57.08 bc	50.54 b	50.41 ab	28.83 abcd
DKC-6022	220.1 ab	12.7 bcde	2.41 ab	69.67 ab	46.31 d	47.12 bc	32.55 abc
MF-714	215.1 ab	12.4 cde	2.32 ab	59.31 abc	41.97 f	42.21 def	24.96 bcd
Tietar	186.4 bc	13.5 abcd	2.43 a	66.81 ab	50.76 ab	50.44 ab	33.77 abc
AG-92148	231.9 a	13.9 abc	2.50 a	71.00 ab	33.14 ı	35.42 h	24.26 cd
Mitic	218.9 ab	12.7 bcde	2.25 ab	79.76 ab	48.39 c	48.17 abc	38.54 a
DKC-6610	221.9 ab	12.8 abcde	2.26 ab	73.35 ab	35.82 h	38.05 gh	27.11 abcd
DKC-6842	173.6 c	10.8 f	2.00 b	39.02 c	54.26 a	53.14 a	20.95 d
Ada-523	234.2 a	13.9 abc	2.38 ab	75.90 ab	44.19 e	45.23 cd	33.94 abc
Goldavid	230.4 a	13.9 ab	2.26 ab	80.45 ab	39.04 g	40.79 efg	32.07 abc
Doge	202.4 abc	13.5 abcd	2.41 ab	64.05 ab	49.26 bc	48.84 bc	31.26 abcd
Vero	190.3 bc	12.7 cde	2.49 a	67.37 ab	36.05 h	37.92 gh	24.88 bcd
Mean	**212.6**	**12.9**	**2.33**	**69.12**	**43.90**	**44.63**	**30.28**

Means followed by different letter(s) are significantly different at the 5% or 1% level of probability

Based on the results of the experiment, it could be concluded that significant differences of various traits were found among the maize cultivars tested. Tansi(1987) stated that in selecting the cultivar for silage maize production, three characteristics of the plant, namely, herbage yield, maturation period and dry matter content in harvest should be considered. It should be emphasized that herbage yield is one of the important characteristics in order to compare the agronomical performances of crops. It is a quantitative trait affected by the correlated traits such as number of the plants per area, genotype, maturation period, harvest date and avaible technology. Alessi and Power (1974); Esser and Entrup, (1980) revealed that herbage yield is a characteristic that closely related to enviromental conditions

There are special total temperature requirements for the favorable growing and maturing cycle for species and cultivars of the crops. For maize, these values are between 2370-3000 ºC (Boguslawski, 1981). Hence, in the regions where the average temperature is quite high, the crops reach to earlier harvest stage by completing the total temperature requirements in a short period. In late spring in mediterranean environments, the increasing air and soil temperatures meet the requirements of the early maturing cultivars and the crops complete their growing cycle by pollen shedding. Consequently, the vegetative growth ceases automatically and the herbage yield decreases considerably. For the mid-late cultivars, vegetative period is longer than the earlier cultivars. Therefore, the vegetative period of mid-late cultivars prolong and herbage yield increases. Our results obtained in the study are not in accordance with the findings of some other researchers(Avcioglu et al.,2001 and Korkut et al.,2009). These due to differences of the ecological conditions of the research areas.

In conclusion, maize cultivars of C-955, Goldavid, Mitic and AG-92150 were found to be recommendable under irrigated growing conditions of Manisa provenance of Turkey.

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