韓草誌 (J. Korean Grassl. Sci.) 19(2) : 177~182, 1999

Heritability and Effects of Some Characters on Silage Yield in Dent Corn Varieties (*Zea Mays indentata Sturt.*) Grown Under Drought Conditions

İsmet BAŞER and Temel GENÇTAN

Summary

This research was carried out in a farm situated in Malkara District of Tekirdag Province (Turkey) in 1994-95, and the effect of genotype and environmental conditions on some characters and variations of these characters in terms of silage yield in 8 dent corn varieties were determined. The results of this research showed that leaf weight, stem diameter, and silage yield had a low broad sense heritability while the number of leaves per plant had a high heritability. Yield performance of varieties varied to a significant degree because of variations in rainfall rate during the growing periods. Leaf number, silage yield, leaf weight, stem diameter, plant height and ear weight varied between 13.33-17.33 number, 8,443-11,114 ton/hec, 152.8-244.2 g, 2,615-2,965 cm, 216.5-252.5 g and 176.2-285.8 g, respectively.

I. INTRODUCTION

Corn is second to wheat in terms of production and third after wheat and rice with respect to sowing area in the world. According to TIS (Turkish Institute of Statistics) data, corn in Turkey is the third most important crop after wheat and barley with 550,000 hectar sowing area and 2,000,000 to production. The Thrace region is the most important wheat and sunflower production area with 600 mm average rainfall per year, but this is rather insufficient for corn. In the last decade, many investigations have been carried out to expand irrigation areas by using dam, lake and ground water sources. These irrigation conditions are also needed for various plant species. Corn has an important potential among these crops and is widely used as grain and silage for animal husbandry. Production of grain and silage corn as a main crop in irrigated areas and silage corn in areas without irrigation have been developing rapidly. Gençtan and Başer (1992) found an important and positive correlation between plant height and number of plants per area with silage yield in three different corn varieties grown as a second crop. Konak (1994) found 7,585-9,357 ton/hec of silage yield in six corn varieties in an experiment. Manga *et al.* (1991) determined that silage yield in second crop corn varied between 6,405-6,462 ton/hec in Mediterranean conditions. A number of corn varieties are sold by different seed companies in the Thrace Region, but there is not enough information about the silage characteristics of these varieties. Evaluation of the

Department of Field Crops of Agricultural Faculty of Thrace University Tekirdağ -TÜRKİYE

characteristics of the hybrid corn varieties in this region is important for local farmers.

A good variety should have excellent adaptation ability. In other words, it should have low genotype and environmental interaction. Total genetic variance is a part of phenotypic variance and provides genotypic differences between phenotypes. Genotype and environment interaction variance is a part of phenotypic variance and explains why genotypes show different responses under various environmental conditions. Different environmental term mentioned above refers to environment, year or both (Bartley and Weber 1952). Allard and Bradshow (1964) determined that variety × year interaction is more important than genotype × environmental interactions, because variety × year interaction can not be under the control of the variations from year to year. As Warner (1952) notes, one of the heritability coefficient estimation methods is based on variance components (Fanous 1969).

Robinson *et al.* (1949) estimated broad sense heritability as 70.1% for plant height and 20.1 for yield using variance methods in three single corn genotypes. Bonaparte (1977) found low heritability coefficient for number of leaves per plant in diallel crossing between six corn genotypes. Debnath (1987) estimated high heritability for plant height while for grain yield and moisture rate of grain found low heritability. Gençtan and Başer (1994) also calculated heritability coefficient as 29% for grain yield in dent corn genotypes in Thrace conditions. Tüsüz and Balaban (1997) determined a low heritability coefficient for plant hieght, yield and tasseling date in dent corn varieties in Mediterranean condition.

This research was carried out in Malkara District of Tekirdag Province in 1994-95 and aimed to determine affection rates of genotype and environmental conditions on some characters having an important effect on silage yield and variations of these characters.

Ⅱ. MATERIAL AND METHODS

Experiments were carried out with 8 hybrid corn varieties (MOLTO, PX-74, P-3358, Rx-9540, RX-947, RX-899, RX-904 and G-640) obtained from various seed companies in Malkara District of Tekirdag Province in 1994-95. In the experiments with establishing in completely randomised block design with three replicates, seeds were sown by sowing machine in 70×10 cm sowing density as 8 rows on plots 10 m in length. 70 kg/hec nitrogen and phosphorus before sowing, 80 kg/hec nitrogen at 25~30 cm of plant height and 50 kg/hec nitrogen before about two weeks tasselling were applied to all parcels. All the procedures in these investigations were carried out under farm conditions without irrigation. Measurements were taken on 10 plants in the same row as Sağlamtimur *et al.* (1980), Anonymous (1987) and Manga *et al.* (1991) when the plants were at milk-dough maturing time for silage. Silage yield was obtained by weighing after harvesting all plants in the plot.

As can be seen in Table 1, rainfall data for May and June in 1994 was higher than long term data, also rainfall data in July was lower than long term. During the same period, relative moisture and average temperatures were higher than long term data. In contrast to 1994, July and August in 1995 had a higher rainfall than long term. Average temperature was also higher than long term.

The data obtained from the experiments were analysed using TARIST computer programme after Yurtsever (1984). Broad sense heritability for

Table 1. Total rainfall, average temperature and relative moisture data during 1994-95 and long term are given

Months	Rainfall (mm)			Average temperature (℃)			Relative moisture (%)		
	Long term	1994	1995	Long term	1994	1995	Long term	1994	1995
April	45.3	36.4	35.4	12.3	13.4	11.8	82.0	80.7	78.7
May	44.7	45.8	19.3	17.0	17.4	17.1	81.1	80.7	74.2
June	40.5	46.8	54.9	21.7	20.5	22.6	77.0	74.5	76.3
July	24.1	56.0	92.8	23.1	24.3	23.8	73.9	70.3	72.4
August	12.5	53.0	45.8	22.9	24.6	23.5	74.5	70.5	73.8
September	23.7	0.00	60.3	19.7	23.4	20.1	77.5	77.8	76.3

characters examined was calculated as a model for two years experiment in one location which is one of the genotypic models including various environmental effects as suggested by Yildirim *et al.* (1979). The variance analysis table relating to this model using is given below.

Sources of variation	d.f.	SS	MS	Expected MS
Years	(y-1)			
Replications	y(r-1)			
Genotypes	(g-1)	G_3 (g-1)	G_3	$\sigma_e^2 + r\sigma_{gy}^2 + ry\sigma_g^2$
Genotype × Year Int.	(y-1) (g-1)	GY_1 (g-1) (y-1)	GY_1	$\sigma_e^2 + r\sigma_{gy}^2$
Error	y(r-1) (g-1)	H_3 y(g-1) (r-1)	H_3	σ_e^2

$$\text{Broad sense heritability} : \frac{\text{genotypic variance}}{\text{phenotypic variance}} : \frac{\sigma_g^2}{\sigma_g^2 + \sigma_{gy}^2/y + \sigma_e^2/ry}$$

According to this model, calculation of heritability coefficient the effect of genotype × environment interaction is accepted to be not significant.

Ⅲ. RESULTS AND DISCUSSION

Average values, significant levels and broad sense heritability for characters examined in 8 corn varieties in this research given in tabels 2 and 3.

1. Plant Height

Table 2 showed that there were significant differences in respect to plant height among corn varieties in this research. Plant height according to average of years varied between 216.5~252.5 cm. The shortest plant height was found to be the PX-74 variety while the highest plant height was of RX-974 and MOLTO. During experimental period, the changes in

Table 2. Average values and important levels relating to plant height, stem diameter, leaf number, leaf weight, ear weight and silage yield of the corn varieties in the experiment

Variety / Name	Plant height			Stem diameter			Leaf number		
	1994	1995	Average	1994	1995	Average	1994	1995	Average
MOLTO	221.3^{bc}	266.3^{a}	243.8^{ab}	2.74^{bc}	2.68^{cd}	2.71^{cd}	13.67^{b}	14.00	13.83^{c}
P-3358	225.7^{b}	253.3^{ab}	239.5^{bc}	2.53^{c}	2.98^{ab}	2.76^{cd}	13.67^{b}	13.67	13.67^{c}
PX-9540	209.7^{cd}	262.3^{a}	236.0^{bcd}	2.99^{a}	2.94^{ab}	2.97^{a}	14.67^{b}	15.67	15.17^{b}
RX-947	245.0^{a}	260.0^{a}	252.5^{a}	2.27^{d}	2.69^{cd}	2.48^{e}	13.33^{b}	13.67	13.50^{c}
RX-899	204.3^{d}	253.7^{ab}	229.0^{de}	2.81^{ab}	3.04^{a}	2.93^{ab}	17.33^{a}	17.33	17.33^{a}
PX-74	202.0^{d}	231.0^{c}	216.5^{f}	2.60^{bc}	2.89^{abc}	2.74^{cd}	14.33^{b}	14.33	14.33^{bc}
G-610	208.0^{d}	238.0^{c}	223.0^{e}	2.79^{ab}	2.90^{bcd}	2.85^{cd}	13.67^{b}	13.33	13.50^{c}
RX-904	224.0^{b}	242.3^{bc}	233.7^{cd}	2.61^{bc}	2.62^{d}	2.62^{de}	14.67^{b}	15.33	15.00^{b}

Variety / Name	Leaf weight			Ear weight			Silage yield		
	1994	1995	Average	1994	1995	Average	1994	1995	Average
MOLTO	196.7^{d}	236.7	216.7^{ab}	203.3^{b}	363.3^{a}	283.3^{a}	9,765.0	12,463.3	11,114.2^{a}
P-3358	200.0^{cd}	211.0	205.5^{b}	263.3^{a}	308.3^{a}	285.8^{a}	9,660.0	11,133.3	10,396.6^{ab}
PX-9540	231.7^{ab}	256.7	244.2^{a}	133.3^{c}	278.3^{ab}	205.8^{b}	9,570.0	10,440.0	10,005.0^{ab}
RX-947	111.8^{e}	193.8	152.8^{c}	158.3^{bc}	198.3^{b}	178.3^{bc}	9,330.0	10,623.0	9,976.5^{ab}
RX-899	201.7^{cd}	221.0	211.3^{ab}	150.7^{c}	285.0^{ab}	217.8^{b}	8,940.0	10,833.3	9,886.7^{ab}
PX-74	208.3^{a}	247.7	228.0^{ab}	151.7^{c}	191.7^{b}	171.7^{bc}	9,280.0	10,033.4	9,656.7^{bc}
G-610	201.7^{cd}	220.0	210.8^{ab}	136.7^{c}	256.7^{ab}	196.7^{bc}	8,400.0	10,200.0	9,300.0^{bc}
RX-904	223.3^{bc}	261.7	242.5^{a}	161.7^{bc}	190.7^{b}	176.2^{c}	8,240.7	8,646.7	8,443.4^{c}

Table 3. Genotypic, phenotypic, environmental variance and broad sense heritability obtained from variance components

Characters	Phenotypic variance	Environmental variance	Genotypic variance	Broad sense Heritability (%)
Plant height	218.73	145.06	73.67	0.34
Leaf number	2.44	0.79	1.65	0.68
Leaf weight	1,447.29	1,146.8	300.5	0.21
Stem diameter	0.0487	0.035	0.0137	0.28
Ear weight	4,819.67	3,047.48	1,772.2	0.36
Silage yield	247,443.5	203,476.9	43,966.5	0.22

rainfall had significant effects on plant height. These effects were more severe in the first year. According to broad sense heritability calculated by using variance components, it was found to be 36% for plant height. Unlike to our results, Debnath (1987) found a higher heritability, however, Tüsüz and Balaban (1997) found

a lower heritability. This variation in heritability may suggest that environmental conditions and variety genotype under drought condition have nearly an equal effect on plant height.

2. Stem Diameter

Important differences were found in respect to stem diameter among corn varieties. Genotype and environmental interaction was also found to be statistically significant. The widest stem diameter according to the two year data was the PX-9540 at 2.97 cm. Next was RX-849 in the same statistical group. The narrowest stem diameter was RX-947 and PX-74 with 2.48 and 2.615 cm, respectively (Table 2). The higher amount of rainfall in second year, compared to the first year, resulted in an increase in silage yield and the stem diameter significantly increased. The low broad sense heritability value for stem diameter (0.28%) implies that environmental factors were proportionally more effective than genotype in terms of stem diameter.

3. Leaf number and weight per plant

Leaf weight and number per plant is desirable character in order to increase silage quality. The differences between varieties in terms of leaf number and weight were significant for both year. Leaf number and weight of 8 hybrid corn varieties according to years average varied between 13.50~17.33 number and 152.8~244.2 g (Table 2). The highest weight of leaves were of the RX-899 and PX-9540. There was an increase in leaf weight despite no significant change in number of leaves between two years. This could be attributed to an increase size of leaf in second year as a result of better climatic conditions compared with the first year. Heritability was found to be low (21%) for leaf weight while it was high (68%) for number of leaves per plant. From these results, it could be said that environmental factors had a higher effect on leaf weight than genotype whereas genotype had a higher effect on leaf number.

4. Ear weight

When ear weight in 8 corn varieties was examined, differences between two years was statistically significant. This situation was due to differences in average rainfall rate between the two years. The highest ear weight in 1994 was obtained from RX-947 with 263.3 g. However, in 1995 the highest data was taken from P-3358 with 363.3 g. The highest ear weight according to years average was P-3358 with 285.8 and MOLTO with 283.3 g (Table 3). There was no significant between years in early varieties (RX-904, PX-74 and RX-947) in terms of ear weight. On the other hand, the differences between years in late varieties (P-3358, MOLTO and PX-9540) was considerably high. This reason for that, early varieties were able to escape from drought period during ear bearing in the first year. Heritability was 36% for ear weight obtained from variance components. This shows that environment conditions and genotypic structure have a similar effect on ear weight (Table 3).

5. Silage Yield

When corn varieties were compared in respect to silage yield, there was no significant differences between the corn varieties in the first year whereas significant differences between the corn varieties were obtained in the second year. Average silage yield in corn varieties varied between 8,443 and 11,114 ton/hec. The highest silage yield according to average of years was obtained from MOLTO and P-3358. In both growing seasons, the response of varieties varied depending upon environmental conditions. Increases in yield differences of MOLTO, P-3358 and G-610 were higher than RX-904, PX-74 and PX-9540. This indicated that MOLTO, P-3358 and G-610 should be

grown in areas which have shorter drought period. The heritability for silage yield was found to low at 0.22% (Table 3). This situation shows that environmental conditions have a higher influence than genotypic structure on silage yield. The results obtained for silage yield and main characters having an important influence on silage yield were found to be similar to the results of Tüsüz and Balaban (1997), Gençtan and Başer (1994), Debnath (1987) and Robinson *et al.* (1987).

According to the results, this experiment conducted in the farm condition without irrigation showed that the significant differences between the varieties were found in respect to silage and effective characters related to yield. According to broad sense heritability calculated from variance components, stem diameter, silage yield and leaf weight were more affected by environmental factors than genotype while ear weight and plant height were affected by environmental conditions and genotype equally. However, leaf number was controlled by genotypical structure at high level.

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