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Effect of Tiller Removing and Plant Density on Ear Yield of Sweet Corn (*Zea mays saccharata* Sturt)

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Abstract: The effects of plant density and tiller removal were determined on yield and agronomic characters of 3 sweet corn cultivars during the growing periods in 1997 and 1998 in Isparta plain in Turkey. Ear yield varied depending on cultivars and the highest ear yield was obtained for cv. Merit in 1997 and 1998 (13.8 and 11.8 t ha^{-1}, respectively). Number of tiller $plant^{-1}$, ear length, ear diameter and filled ear length decreased in high plant density (9.5 plants/m^2). Plant height and ear yield increased as the plant density increased. While tiller removal did not affect statistically significant any characters except the filled ear length in sweet corn varieties in 1997. It reduced plant height and ear yield in the second experimental year.

Key words: *Zea mays saccharata* Sturt, cultivars, plant density, tiller removal, ear yield

Introduction

Sweet corn (*Zea mays saccharata Sturt*) differs from all other types of corn, because it produces and retains large amounts of sugar in the kernels (Walter, 1991). Improved cultural practices, such as fertilization, higher yielding cultivars and higher plant population, have led to increase sweet corn production (Patel *et al*., 1988). Rogers and Lomman (1988) reported that the highest ear yield for cv. Honey Sweet was obtained at 8-12 plants/m^2 but above 8 plants/m^2, kernel fill and ear diameter decreased rapidly. Yodpetch and Bautista (1986) concluded that kernel fill decreased as densities increased from 6 to 18 plants/m^2 in the sweet corn cultivar Super Sweet.

The branches of a grass rising from the nodes below the soil surface are known as tillers or suckers. The aerial branches develop as rudimentary or functional ear shoots and large number of tillers may arise under favourable environmental conditions and each tiller develops a root systems of its own (Leonard and Martin, 1963). Tillering varies widely among cultivars in maize and nearly all cultivars of sweet corn tiller more or less abundantly (Crockett and Crookston, 1980). In general, manual removal of tillers has been practiced in sweet corn production. But there is little information on effect of tiller removal on yield and yield components in Turkey. Sencar *et al*. (1999) reported that tiller removal significantly reduced the ear weight in first crop production of sweet corn. The results of Park *et al*. (1989) showed that tiller production was reduced by increased plant density and tiller removal did not significantly affect ear yield and other characters except the plant height.

The aim of present study was to determine the effect of tiller removal on some agronomic characters and yield of sweet corn cultivars grown at different plant densities.

Materials and Methods

The experiment was conducted in the plain of Isparta in 1997 and 1998 growing seasons. The average temperature values during the periods were similar to that long term averages. The total precipitation was the climatic factor that caused the differences between averages in both experimental years and in the long term averages. Precipitation in the second year of growing period (239.9 mm) was higher than that of the first year (171.0 mm). The soil was clay–loam, alkaline, unsalted and rich in K, but medium in organic matter. The experiment consisted of all combinations of four cultivars (Adapazari, Merit, Ag9101 and Bonanza) at three plant densities (4.1, 5.7 and 9.5 plants/m^2) and two treatments (tiller removal and control) in a split, split plot design with three replicates. The plots were in a 5 x 2.8 m^2 size. The harvest area was 4 m x 1.4 m = 5.6 m^2 size. Tillers were pulled out when they were less than 15 cm tall. The experimental area was fertilized by 80 kg P_2O_5 ha^{-1} and 75 kg N ha^{-1} during the sowing time and by 75 kg N ha^{-1} when plants had 8–10 leaves, based on the results of soil - testing. The number of tillers per plant, plant height, ear length, ear diameter, filled ear length, ear yield and marketable ear yield without husk were determined according to Sencar *et al*. (1999). The results were evaluated by MSTAT-C statistic programs and the differences between the mean of treatments were statistically compared by Duncan's as multiple range test.

Results

The differences among cultivars in number of tillers $plant^{-1}$ were statistically significant in 1997 ($p<0.05$) and 1998 ($p<0.01$) (Table 1) . The highest number of tillers $plant^{-1}$ was observed in cv. Merit and the lowest was determined in cv. Adapazari in both years. The number of tillers $plant^{-1}$ in the control plants decreased linearly by increased plant density in 1997 and 1998.

Cv. Adapazari had the shortest maturity period and the longest maturity period was found with Merit variety in both 1997 and 1998. The maturity period increased as plant density increased, but it was not affected by tiller removal treatment. Cv. Merit gave the highest plant height with the value of 171.0 cm and the lowest plant height was measured in cv. Adapazari in 1998. Plant density affected the plant height ($p<0.05$ for 1997 and 1998) and plant height was increased significantly through the increased density. In the first experimental year, tiller removal did not affect plant height. However, the effect of tiller removal on plant height was statistically significant in 1998 ($p<0.05$).

Ear length was affected by varieties in the second experiment year ($p<0.01$). The cv. Merit had greater ear length than any other varieties. Ear length increased as the plant density decreased in both years ($p<0.01$). The tiller removal treatment did not affect ear length in both experimental years. From a detailed examination of the results (Table 1), it can be noted that the highest ear diameter was seen in Merit cultivar in 1997. Ear diameter was affected by all the densities ($p<0.01$ for 1997 and 1998). In both years, the highest ear diameter was observed at the lowest density (4.1 plants/m^2). According to ear diameter, there was no difference between tiller removal treatments in the two experimental years. In both years, the highest filled ear length was obtained from cv. Merit with 18.7 and 19.2 cm, respectively (Table 2). As shown (Table 2), kernel fill decreased as densities increased from 4.1 to 9.5 plants/m^2. Whereas tiller removal did not affect significantly the filled ear length in 1998. Filled ear length increased by tiller removal in 1997 ($p<0.01$).

The highest ear yield and marketable ear yield were obtained from cv. Merit in 1997 and 1998 (Table 2). Ear yield increased as plant density increased from 4.1 to 9.5 plants/m^2. On the contrary, marketable ear yield was negatively affected by plant densities in 1998 ($p<0.01$). The lowest marketable ear yield was determined in 9.5 plants/m^2. In the second experimental year, ear yield and marketable ear yield were reduced by tiller removal treatment ($p<0.01$).

Table 1: The agronomic characters of sweet corn hybrids as affected by plant densities and tiller removal

	No. of tillers/plant		Maturity period (day)		Plant height (cm)		Ear length (cm)	
Treatments	1997	1998	1997	1998	1997	1998	1997	1998
Cultivars (C)								
Adapazari	1.7^{b}	1.5^{b}	86.7^{b}	88.2^{b}	166.8	161.9^{b}	17.9	16.5^{c}
Merit	2.3^{a}	2.4^{a}	94.2^{a}	93.7^{a}	173.1	171.0^{a}	19.9	20.3^{a}
Ag9101	2.1^{ab}	2.0^{a}	90.3^{b}	91.2^{ab}	170.7	168.5^{a}	19.1	16.5^{c}
Bonanza	2.0^{ab}	2.0^{a}	91.1^{ab}	90.8^{ab}	161.4	166.7^{ab}	18.1	17.2^{b}
Signif.(x)	*	**	**	*	NS	*	NS	**
Plant densities (PD) (plants/m^2)								
4.1	2.8^{a}	2.9^{a}	89.7^{b}	89.3^{b}	165.8^{b}	163.8^{b}	19.9^{a}	18.9^{a}
5.7	2.0^{b}	2.0^{b}	90.8^{a}	91.6^{a}	167.4^{ab}	167.1^{ab}	18.9^{b}	17.5^{b}
9.5	1.2^{c}	1.1^{c}	91.0^{a}	91.9^{a}	170.8^{a}	170.1^{a}	18.0^{b}	16.4^{c}
Signif.(x)	**	**	*	*	*	*	**	**
Tiller removal (TR)								
Control	-	-	90.3	90.7	169.1	168.2^{a}	19.0	17.5
Removal	-	-	90.7	91.0	166.9	165.8^{b}	18.8	17.7
Signif.(x)	-	-	NS	NS	NS	*	NS	NS
Average	2.0	2.0	90.5	90.9	168.0	167.0	18.9	17.6
CxTR	-	-	NS	NS	NS	NS	NS	NS
PDxTR	-	-	NS	NS	NS	*	NS	NS
CxPDxTR	-	-	NS	NS	NS	NS	NS	NS

Table 2: The ear yield and other characters of sweet corn hybrids as affected by plant densities and tiller removal

	Ear diameter (mm)		Filled ear length (cm)		Ear yield (t ha^{-1})		Marketable ear yield (t ha^{-1})	
Treatments	1997	1998	1997	1998	1997	1998	1997	1998
Cultivars (C)								
Adapazari	45.4^{d}	45.5	16.6^{b}	15.4^{b}	11.1^{c}	10.0^{b}	9.9^{c}	8.0^{c}
Merit	48.3^{a}	46.8	18.7^{a}	19.2^{a}	13.8^{a}	11.8^{a}	11.7^{a}	9.8^{a}
Ag9101	47.1^{b}	45.8	18.2^{a}	15.6^{b}	12.4^{b}	10.4^{b}	10.0^{bc}	8.9^{b}
Bonanza	46.4^{c}	45.3	17.9^{a}	15.7^{b}	12.0^{b}	11.7^{a}	10.6^{b}	9.7^{a}
Signif.(x)	**	NS	*	*	**	**	**	*
Plant Densities (PD) (plants/m^2)								
4.1	48.3^{a}	47.0^{a}	18.7^{a}	17.5^{a}	11.3^{b}	10.2^{c}	10.2	9.0^{b}
5.7	46.9^{b}	45.8^{b}	17.8^{ab}	16.3^{a}	12.6^{b}	10.1^{b}	11.1	9.3^{a}
9.5	45.2^{c}	44.8^{c}	17.1^{b}	15.5^{b}	13.0^{a}	11.8^{a}	10.5	8.9^{b}
Signif.(x)	**	**	**	**	**	**	NS	**
Tiller Removal (TR)								
Control	46.7	45.8	17.1^{b}	16.4	12.4	11.2^{a}	10.6	9.1^{a}
Removal	46.9	45.9	18.6^{a}	16.5	12.2	10.8^{b}	10.5	9.0^{b}
Signif.(x)	NS	NS	*	NS	NS	**	NS	**
Average	46.8	45.9	17.8	16.5	12.3	11.0	10.6	9.1
CxTR	NS	NS	NS	NS	NS	**	NS	NS
PDxTR	NS	NS	NS	*	**	NS	NS	NS
CxPDxTR	NS	NS	NS	NS	NS	NS	NS	NS

(x) Effects were significant at the 5% (*) or 1% (**) level or not significant (NS)

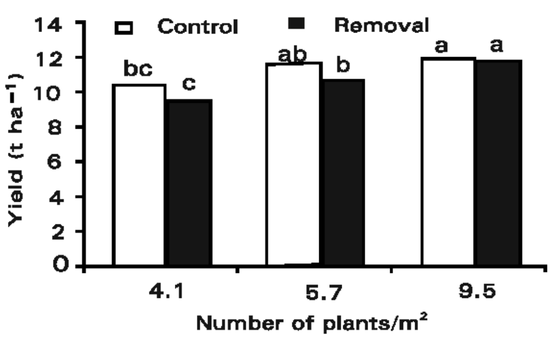

Fig. 1: The effect of plant density and tiller removal on ear yield

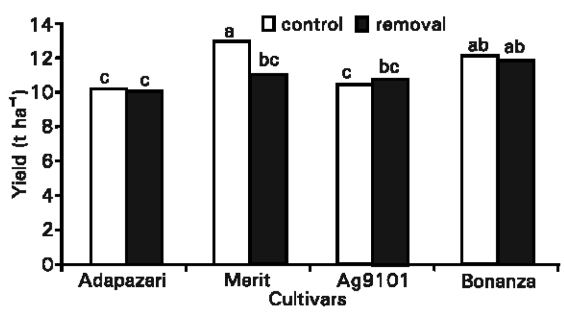

Fig. 2: The effect of cultivars and tiller removal on ear yield

Significant plant density x tiller removal interaction was found for ear yield ($p < 0.01$) in 1997. Ear yield did not show any significant decrease at the tiller removal treatment in all plant densities. However the decreasing of ear yield at 4.1 plants/m^2 of tiller removal was more definite when compared with other plant densities (Fig. 1). The effect of cultivar x tiller removal interaction on the ear yield was significant ($p < 0.01$) in 1998. In Merit cultivar, ear yield was negatively affected by tiller removal in comparison with other cultivars (Fig. 2). Cultivar x tiller removal, plant density x tiller removal and cultivar x tiller removal x plant density interactions were found non-significant for almost all the investigated characters in research.

Discussion

The differences among varieties based on the number of tillers plant^{-1} were due to their heredity. As a matter of fact, Walter (1991) reported that the number of tiller produced in sweet corn plant depends upon the cultivars. High plant density in this research affected negatively this character. Similarly, Crockett and Crookston (1980) determined that tiller production decreased with increasing plant density in corn. Akman (1998) also reported that plant height varied in accord with cultivars. The increasing plant height as the plant density increase can be attributed to the interplant competition for light at high density, because cell elongation in the lower side of the nodes increased due to reduced sunlight or increased shading (Martin *et al.*, 1976). Rogers and Lomman (1988) also found increases in the plant height at high plant density. Plant height was reduced by tiller removal treatment. This result showed similarity to the findings of Park *et al.* (1989) and Sencar *et al.* (1999). Ear diameter decreased as the plant density increased. The main reason of this decrease was the interplant competition for light, water and nutrients at high density (>5.7 plants/m^2). Similar results were also reported by Karim *et al.* (1985).

Ear yield differences among cultivars were resulted from their heredity. Ear yield increased as plant density increased. This generally agrees with the observations of other researchers (Tsai and Chung, 1984; White, 1984). Russelle *et al.* (1984) also reported that ear weight increased with increased plant densities except in case of cultivars which tend to produce more than one ear at low plant density levels in field corn. On the other hand, decrease of marketable ear yield at the highest plant density can be explain with increasing ears with low marketing value based on competition among the plants for light and nutrients at the highest plant density.

The results in the second year indicated that tiller removal reduced the ear yield and marketable ear yield, especially at the low plant densities. This result can be explained to the decrease of the number of ears plant $^{-1}$. As a matter of fact, Walter (1991) informed that the tillers of sweet corn tend to produce fertile ears. Sencar *et al.* (1999) recommended that the tillers of sweet corn should not be removed and also informed that their removal reduced the ear yield. Similarly, Park *et al.* (1989) reported that tiller removal had no advantage at any plant density for sweet corn production.

The determination of non-significant effect of evaluated interactions on many investigated characters can be explain with having a slight effect of tiller removal treatment on this parameters.

In conclusion, the highest ear yield was obtained from Merit sweet corn variety and at the highest plant density in this research. Tiller removal treatment decreased ear yield in the second year of experiment. Based on the results of two experimental years, it can be recommended that tillers or suckers of sweet corn should not be removed.

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