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EVALUATION OF DEVELOPED STANDARD SWEET CORN (*Zea mays sacharata* L.) HYBRIDS FOR FRESH YIELD, YIELD COMPONENTS AND QUALITY PARAMETERS

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ABSTRACT

Sweet corn is primarily grown for fresh consumption, canning or freezing and harvested during the milky stage. Sweet corn growing is getting increasing in Turkey. To meet growers demand sweet corn variety breeding program has been carried out at West Mediterranean Agricultural Research Institute since 2000. Pedigree breeding procedure was applied to develop new sweet corn varieties. The objective of the study was to evaluate newly developed some sweet corn candidate hybrid varieties for their fresh yield, some yield components and determine some quality parameters in different locations of Turkey. In the present study, four candidate sweet corn hybrids (BT-1, BT-2, BT-3 and BT-4) which were selected from previous trials for further evaluations and three commercial checks, Jubilee, Merit and Sunshine were compared and the results were discussed. According to the results, BT-4 was determined as a new promising hybrid among the four candidates for fresh yield and some quality parameters.

Key words: Sweet corn, Hybrid, Fresh ear yield, Quality

INTRODUCTION

Sweet corn is a variety of corn with high sugar content. It differs from field or starchy corn in terms of its genetic background. Sugary (su), sugar enhanced (se) and supersweet or shrunkenken (sh2) are three main genetic groups of sweet corn. Sugary (su) varieties have relatively low sugar content in their kernels compared with other sweet corn types. The predominant sugar in su varieties is sucrose, with lesser amount of maltose, glucose and fructose (Cob and Hannah, 1981). Laughnan (1953) first described the cultivar using sh2 endosperm mutant gene found in the supersweet corn types. The sh2 gene raises sucrose content to more than % 35 of the kernel. Mentioned amount of sucrose is twice of the su varieties. Sh2 varieties can be stored long time after harvest. However, creamy texture often associated with su varieties is absent in supersweet corn varieties (Marshall, 1988). Also some sweet corn types carry se genes that can be described as modification of the supersweet corn types.

Sweet corn production and consumption is getting increasing in Turkey. There is no enough statistical data on production amount and area of harvest in Turkey. However, sweet corn demand is high and mostly imported. Frozen sweet corn kernels are in the first rank in the import. Turkey's frozen sweet corn export value was 85 tons in 2008 and 70 tons in the year of 2009 and recorded import value was 4547 tons in 2008 (Aydin, 2010; Anonymous, 2011).

Breeding new high yielding sweet corn varieties may play an important role in the increasing of the production area and also may help import amount reduce. Therefore, a program called sweet corn variety breeding was initiated in 2000.

The objective of the study was to evaluate newly developed some sweet corn candidate varieties for their fresh yield and some yield components and determine some quality parameters for some hybrids.

MATERIALS AND METHODS

In the study, partially inbreds which were developed in the sweet corn variety program were evaluated for their combining ability by topcrossing method in 2005. Inbred that have good combining ability were selected and used in the crossing studies. Many candidate sweet corn hybrids were evaluated in Antalya and Sakarya conditions in 2006 and 2008. Four candidate sweet corn hybrids, BT-1, BT-2, BT-3 and BT-4 selected for further evaluations from the experiments. In the present study, selected hybrids plus three commercial checks, Jubilee, Merit and Sunshine were compared and the results discussed.

Two experiments were carried out at the Bahri Dagdas International Agricultural Research Institute, Konya (37052'N, 32035'E) and West Mediterranean Agricultural Research Institute, Antalya (36052'N, 30045'E) in 2010. Experiments were conducted in a Randomized complete block design with three replications. Plots consisted of four rows, 5 m long and row spacing was 0.7 m. Border rows were also included to eliminate border effects. After emergence, plants were thinned to approximately 0.2 m. Fertilization and plant protection

measures were done according to local recommendations. Nitrogen was applied 2 times: 10 kg before sowing and 10 kg at the fifth leaf stage. Duration of tasseling, plant height, ear height, ear diameter, ear length and fresh ear yield per plot were measured. Harvests were done manually and late varieties were harvested as they came to maturity. Quality parameters such as total sugar content (%), starch (%), oil (%), total protein content (%) and dry matter (%), were also determined for three checks and a promising candidate hybrid at West Mediterranean Agricultural Research Institute Medicinal and Aromatic Research Laboratory. Analysis-of-variance (ANOVA) was conducted on the data for both locations and least significant difference (LSD) tests were used (Cochran and Cox, 1957) to determine differences among varieties.

RESULTS AND DISCUSSION

The site by variety (SxV) interaction was not significant for nearly all traits analyzed except duration of tasseling (Table 1). Non-significant SxV interactions indicated that individual varieties performed similarly at the two locations. According to investigated traits, significant differences identified between two locations except ear height. Varieties were different in terms of duration of tasseling, ear diameter, ear length and fresh ear yield. Plant height and ear height were not significant in both locations (Table 3).

Table 1. Results of combined analysis of variance

Source	Duration of tasseling	Plant height	Ear height	Ear diameter	Ear length	Fresh ear yield
Site	**	**	NS	**	**	**
Variety	**	NS	NS	**	**	**
SxV	*	NS	NS	NS	NS	NS
C.V	2.4	7.8	18.3	5.5	5.2	15.1

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

Table 2. Mean fresh ear yield (t ha^{-1}) of the hybrids in the previous experiments

	2006	2008		2010	
Varieties	Antalya**	Antalya^{NS}	Sakarya**	Antalya^{NS}	Konya**
Merit	5.9 g	6.6	40.3 a	13.1	10.2 a
Sunshine	-	-	-	12.8	11.2 a
Jubilee	9.3 be	5.6	28.0 bc	11.3	8.7 ab
BT-4	11.5 a	6.4.	31.0 b	11.5	9.9 a
BT-2	10.6 ab	8.4	-	11.0	7.2 bc
BT-3	10.5 ac	10.0	-	10.7	7.0 bc
BT-1	10.2 ac	9.1	30.8 b	10.4	5.0 c
Mean	9.2	6.4	30.7	11.5	8.5

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

Non-significant SxV interaction for fresh ear yield indicated that individual hybrids tended to give similar yield results. When the fresh ear yield of experiments was considered, sweet corn hybrids took place in the same ranking. Checks, Sunshine and Merit had the highest yield in both locations followed by a promising hybrid BT-4 and a check, Jubilee. When the mean fresh ear yield of variety test conducted in both locations was considered, there were significant differences determined between hybrids. Combined results of the two locations showed that cultivar candidate Sunshine check was on the first rank with 12.0 t ha^{-1}, Merit check was on the second rank with 11.7 t ha^{-1}, BT-4 candidate hybrid was on the third rank with 10.7 t $ha^{-1}$and Jubilee check was on the fourth rank with 10.0 t ha^{-1}.

The mean fresh ear yield of the hybrids in the previous experiments different years summarized in the Table 2. BT-4 candidate hybrid had a good ability to produce fresh ear and can be thought as a stable variety. Generally, BT-4 candidate hybrid close to the check Merit and gave higher fresh ear yield than the check Jubilee. Merit and Jubilee checks are more popular in Turkey and used in many different studies than Sunshine (Turgut, 2000; Kara and Akman, 2002; Oktem et al., 2004; Esiyok et al,, 2004; Oktem and Oktem, 2006; Turgut and Balcı, 2006; Erdal et al., 2010). Sunshine is relatively new hybrid for Turkey. However our study showed that Sunshine is a good hybrid nearly in terms of all traits investigated for both locations.

Ear length was significantly different among sweet corn cultivars and varied from 18.5 cm to 20.4 cm. Check Sunshine produced longest ear (20.4 cm), while shortest ear length (18.5 cm) was recorded in candidate hybrid BT-2 (Table 3). Similar results were also reported by Oktem and Oktem (2006) and Tuncay et al. (2005). Oktem (2008) reported that ear length and fresh ear yield is significantly and positively correlated in sweet corn. In our study hybrids which had longer ear also had good yield.

Days to tasseling were between 55 to 61 days and statistically significant at 0.05 level in Antalya location. A commercial check, Sunshine, was the earliest hybrid in the location followed by other two checks, Merit and Jubilee. Our candidates relatively late when compared to the checks. Hybrids were significantly different at 0.01 level in terms of days to tasseling in Konya location. In this location, tasseling time was between 61 and 64 days. Similar results that checks were earlier than candidates obtained from this location as well. Combined analysis of two location showed that Sunshine was the earliest hybrid followed by Merit and Jubilee (Table 3).

Table 3. Means of the traits measured in sweet corn hybrids

Varieties	Fresh ear yield (t ha^{-1})	Ear length (cm)	Days to tasseling Antalya	Konya	Plant height (cm)	Ear height (cm)	Ear diameter (cm)
Merit	11.7 ab	19.5 ab	60 b	61 a	178	46.0	4.5 ab
Sunshine	12.0 a	20.3 a	55 a	62 ab	180	45.0	4.7 a
Jubilee	10.0 bc	20.4 a	60 b	61 a	176	44.0	4.3 bc
BT-4	10.7 ac	18.6 b	61 b	63 c	194	55.5	4.2 c
BT-2	9.1 ce	18.5 b	61 b	64 c	175	49.0	4.2 c
BT-3	8.9 ed	18.9 b	61 b	64 c	183	51.3	4.4 bc
BT-1	7.7 e	18.8 b	61 b	63 c	177	51.0	4.1 c
Mean	10.0	19.3	59.9	62.6	180.8	48.8	4.3

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

Plant height was not significantly different among hybrids tested in the locations. Plant height values varied 175 cm to 194 cm. BT-4 hybrid was identified as the tallest hybrid (194 cm). Our plant height results similar to that of Oktem and Oktem (2006) and upwards of Idikut et al. (2005). When sweet corn is harvested, the entire ear with husk is harvested and residue can be used as silage. Sweet corn residue silage has potential nutritive value for ruminant animals (Idikut et al. 2009). Therefore hybrids which have higher plant height have an advantage for using as silage.

Ear height was not significantly different among hybrids tested in the locations. Ear height values varied from 44.0 cm to 55.5 cm. (Table 3.). BT-4 hybrid had the highest ear height value (55.5), while Jubilee check had the lowest ear height value (44 cm). Ear height results of our study similar to that of Turgut (2000) and upwards of Bozokalfa et al. (2004).

Ear length was significantly different among sweet corn cultivars and ranked from 18.5 cm to 20.4 cm. Check Sunshine produced longest ear (20.4 cm), while shortest ear length (18.5 cm) was recorded in candidate hybrid BT-2 (Table 3). Similar results were also reported by Oktem and Oktem (2006) and Tuncay et al. (2005). Oktem (2008) reported that ear length and fresh ear yield is significantly and positively correlated in sweet corn. In our study hybrids which had longer ear also had good yield.

Mean ear diameter values were significant at 0.01 level and values varied from 4.1 to 4.7 cm. Highest ear diameter (4.7 cm) was recorded in a commercial hybrid Sunshine which is followed by another check Merit with 4.5 cm (Table 3). Similar ear diameter values were reported by Tuncay et al. (2005) and Bozokalfa et al. (2004).

Quality parameters in the mature seeds, such as total sugar content (%), ratio of starch (%), ratio of oil (%), ratio of protein (%) and dry matter ratio (%) of the promising hybrid BT-4 and three commercial checks was shown in Table 4. Genotypes that have higher level of sugar are preferable for industrial purposes and for fresh consumption. As it can be seen from the Table 4, BT-4 candidate hybrid was in the first rank with % 9.4 total sugar content and draws attention when compared to the checks with a higher sugar content. In a report by Variety Registration and Seed Certification Centre of Turkey, checks used in this study had lesser amount of sugar (Sunshine % 5.0, Jubilee % 5.1 and Merit % 4.5) content (Anonymous 2010). However, this could be a result from seed source that grown in different ecological conditions. Starch and oil content of the hybrids generally close to each other. Analysis also showed that a check, Jubilee had higher amount of protein in its seeds.

Table 4. Quality parameters of the checks and a best promising hybrid

Hybrid	Total sugar (%)	Starch (%)	Oil (%)	Protein (%)	Dry matter (%)
Sun Shine	5.4	61.1	5.9	8.3	92.0
Jubilee	6.1	55.9	5.0	11.2	91.6
BT-4	9.3	51.1	5.3	5.6	91.8
Merit	5.5	60.1	5.2	3.9	92.0
Mean	6.5	57.0	5.3	7.2	91.8

CONCLUSION

Breeding new sweet corn hybrids can contribute to the sweet corn production of Turkey. According to the results of the experiments it seems that BT-4 candidate hybrid is an equivalent or more to the checks in terms of fresh ear yield, some yield components and some quality parameters. On the other hand our study showed that check Sunshine is a good hybrid for nearly all traits investigated.

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