EFFECT OF HARVEST AT DIFFERENT MATURATION STAGES ON FRESH EAR YIELD AND EAR CHARACTERISTICS OF SWEET CORN (*Zea mays* L. *saccharata*) GENOTYPES

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Abstract. This research was conducted in order to determine the effect of harvesting at different maturation stages in some sweet corn genotypes on fresh ear yield and ear components. The experiment was carried out in 2016 and 2017 under Sanliurfa conditions, Turkey. Experiment was established according to the split plots experimental design with three replications. Five sweet corn varieties, Baron, Vega, Jubile, GSS-5649 and Merit were used as plant material in the research. As the harvest maturation stages; according to the Zadoks scale, the periods of early milk maturation (Z73), middle milk maturation (Z75), late milk maturation (Z77), early yellow maturation (Z83), middle yellow maturation (Z85) and late yellow maturation (Z87) were used. The varieties used in the study were placed in the main parcels and the harvest times in the sub plots. During the research, ear features and fresh ear yield were determined. The research results indicated that tested characteristics showed statistically significant difference according to cultivars and harvest time in both years ($p \leq 0.01$). It was determined that fresh ear yield, fresh kernel weight of single ear, fresh single ear weight and ear diameter increased at the harvests made in late maturation stages. Fresh ear yield was lower in harvests made in early maturation periods. The highest fresh ear yield was determined in the middle yellow maturation period. GSS-5649 sweet corn variety was found the best among other tested varieties.
Keywords: *Zadoks scale, growing stage, cob yield, variety, ear properties*

Introduction

Sweet corn is one of the most popular vegetables and it is gaining importance day to day throughout the countries of the globe including Turkey. It is a variety of corn with high sugar content and has a high nutritional value (Santos, 2014). Sweet corn, which is a grain, is used in human nutrition and can be used fresh as well as consumed as processed food. It is a product used in canning, corn flour, starch and oil industries. In addition, by using sweet corn, snacks, chips, confectionery, baby foods and salad dressings are made (Oktem and Oktem, 2005).

Fresh sweet corn products like sweet corn milk and soups are gaining popularity in many countries, while sweet corn ears are eaten green as highly prized fresh product. In addition, frozen sweet corn ears and kernels are preferred in many countries (Oktem et al., 2010). Processing of corn is used to increase its shelf life but as a consequence, a significant loss of nutrients may occur via heat degradation or leaching (Scott and Eldridge, 2005). Sweet corn is harvested at immature stages of endosperm development and used as both fresh and processed vegetable, besides serving as an important source of fibre, minerals, and vitamins (Khanduri et al., 2011).

In recent years, it has also been used in the field such as the fuel industry. Due to early harvest of sweet corn cobs, the remaining green parts can be used in the animal feeding

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directly or as silage (Oktem et al., 2003). Further, after the harvest of sweet corn cobs, green plants serve as a source of large quantities of fodder to the cattle, and therefore provide extra sources of income to farmers (Bian et al., 2015). The demand of sweet corn has increased tremendously in the last few years primarily due to urbanization, increased consumption and availability of organized food processing industries (Lertrat and Pulam, 2007).

Subaedah et al. (2021) reported that effect of the harvest time on ear length and ear diameter were statistically significant. Master sweet corn variety had the longest ear (28.08 cm), whereas the Talenta variety had the shortest (25.33 cm) in ear length. Longest ear diameter was found in the Bonanza variety (6.18 cm), whereas the shortest was found in the Talenta variety (5.96 cm). Harvest of 75 day after planting produced the largest ear diameters. Fresh ear weight of sweet corn was influenced by harvest time. The highest ear weight was seen at harvesting of 75 day after planting (372.22 g ear^{-1}). Bonanza variety produced the heaviest ear (374.17 g ear^{-1}), whereas the Talenta variety produced the lightest (310.83 g ear^{-1}). Fresh ear yield ranged from 16.98 to 22.33 tons ha^{-1} and delaying harvest time resulted higher yield.

Soon et al. (2004) researched harvest times at sweet corn. Ears were harvested at 21, 28, 35, 42, 49 and 56 days after silking. In parallel with the development of the seeds, the seed weight and yield of sweet corn increased with the delay of the harvest time. The optimum harvest time was reported as 42 days after silking. In addition, it was reported that the ear yield was influenced by harvest time and late harvest was the most favourable for high yield (12.2 t ha^{-1}), whereas early harvest gave the least (13.9 t ha^{-1}) ear yield (Mehta et al., 2017).

Szymanek (2009) stated that ear length was between 20 and 23 cm and ear diameter 41 and 49 mm, the number of kernels per row between 27 and 28 pcs. Also Szymanek (2009) emphasized that the fresh ear yield increased from 15.88 to 18.64 t ha^{-1} with delaying harvest time. When the moisture content decreased from 77.41% to 69.83% with delayed harvest date, a decline was observed in the sweet corn quality but yield increased.

Since sweet corn is mostly used fresh in human nutrition, it is very important to harvest it when its nutritional values, ear and kernel yield are highest (Oktem and Oktem, 1999). Yield of sweet corn is influenced by varieties and by harvest time (Saruhan and Oktem, 2021). In this study, it was aimed to determine the effect of different harvest times on the fresh corn yield and some ear characteristics and to determine the most appropriate harvest time for different sweet corn varieties.

Material and Methods

This research was conducted in 2016 and 2017 under Sanliurfa, Turkey conditions in order to determine the effect of harvesting at different maturation stages in some sweet corn genotypes on fresh grain yield and ear characteristics.

Looking at the climate data of the research area from *Table 1*, it is seen that the experimental area has a semi-arid climate, a significant part of the annual precipitation occurs in winter and spring, and the weather is dry and hot in summer and autumn months. During the trial years, rainfall and relative humidity was seen very low in June, July and August (*Table 1*). There was no climatic factor limiting corn cultivation, and the plants were grown without any problems with the irrigation.

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Table 1. *Some climatic data of 2016 and 2017 years of the research area*

Months	Av. Temp. (°C)			Precipitation (kg m²)			Relative humidity (%)		
	2016	2017	Long years	2016	2017	Long years	2016	2017	Long years
January	4.7	5.4	5.7	95.6	9.0	85.7	70.3	61.9	70.3
February	11.6	7.7	7.0	17.1	1.8	71.4	61.8	45.3	66.9
March	13.6	12.7	11.0	13.0	55.2	64.1	50.3	57.1	60.4
April	20.6	16.6	16.2	27.1	79.2	46.8	36.1	50.2	56.2
May	23.2	22.9	22.3	12.3	7.2	28.1	38.3	39.0	44.9
June	29.8	29.7	28.2	0.6	0.0	3.6	28.0	27.0	32.8
July	33.0	34.2	31.9	0.2	0.0	0.6	25.4	22.9	30.0
August	33.2	32.2	31.2	0.0	0.0	0.8	30.6	35.7	33.1
September	26.4	29.6	26.8	0.0	0.0	3.3	32.1	28.8	35.8
October	22.1	20.5	20.2	22.0	17.1	27.4	35.9	36.9	46.4
November	12.6	13.4	12.7	23.3	17.4	46.0	42.9	56.0	59.9
December	5.4	10.3	7.5	101.1	9.5	77.4	70.1	60.2	69.9
Mean	19.7	19.6	18.4	26.0	16.4	37.9	43.5	43.4	50.6

The soil properties of the research area have a clay structure, low organic matter, alluvial, flat and deep soils. In addition, the soils of this area are calcareous and rich in potassium. Cation Exchange Capacity (CEC) was high and increasing towards the lower layers depending on the clay content. Field capacity of the soil was 33.8% on dry basis, permanent wilting point was 22.6% and bulk density was 1.41 g cm^{-3} (Dinc et al., 1988). The soil properties are given in *Table 2*.

Table 2. *Some physical and chemical properties of the trial area soil*

Deep (cm)	Organic matter (%)	EC (ds m^{-1})	pH	Lime (%)	P_2O_5 (kg da^{-1})	K_2O (kg da^{-1})
0-20	1.04	1.0	8.06	25.8	5.76	144.8

Baron, Vega, Jubile, GSS-5649 and Merit single cross hybrid sweet corn genotypes were used as plant material due to they were high yielding, the most grown cultivars and the preferred by consumer.

The experiment was set up in a split-plot design with 3 replications. Genotypes were placed in the main plots, and the harvest times were placed in sub plots. As the harvest times; according to the Zadoks scale (Zadoks et al., 1974), the periods of early milk maturation (Z73), middle milk maturation (Z75), late milk maturation (Z77), early yellow maturation (Z83), middle yellow maturation (Z85) and late yellow maturation (Z87) were used. Harvest was done at the times indicated for each variety.

At sowing, 80 kg ha^{-1} of pure N, P and K, as a 15-15-15 composed fertilizer, was applied to each plot; this was followed by 170 kg ha^{-1} of pure N as urea when the plants reached 30-40 cm in height.

Research area first ploughed with a mouldboard plough, then processed with a goble disc and made ready for planting by pulling the float. In the experiment, each plot consisted of 4 rows with 5 m long. Row spacing was 70 cm, intra row spacing was 20 cm and sowing depth was 3-4 cm. Sowing was done on 20 June 2016 and 22 June 2017 with a pneumatic seed drill.

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After sowing, parcels were irrigated by sprinkler irrigation method and germination of seeds was provided. After the emergence of plants, plots were irrigated equally by the furrow irrigation system towards to harvest time. Plants were irrigated with 10-day intervals and 830 mm of total irrigation water was given throughout the vegetation period. In order to prevent the passage of water between the parcels, a two-meter gap was left between the parcels and the parcels were surrounded by a bank.

Fresh ear length value was measured as cm by measuring the distance from the point where the ear stalk meets the grain to the ear tip in 10 samples taken randomly from each plot. Fresh ear diameter was found by measuring in mm with the help of a caliper from the mid-point of the ear in 10 samples taken randomly from each plot.

In 10 ear samples taken randomly from each plot, kernel number of ear value was determined by counting the kernels present on the ear. Fresh kernel weight of ear value was calculated by averaging the grain weight of 10 samples taken randomly from each parcel.

Fresh single ear weight was determined by weighing and averaging 10 ear samples taken randomly from each plot. Fresh ear yield was obtained by taking the fresh ear weight in each trial plot and converting it to decare. When the plants reached 15-20 cm, the hoe was made with the tractor. Weed control was done mechanically.

An analysis-of-variance (ANOVA) was performed using Jump 5.0.1. statistical package program to evaluate statistically differences between results. Means of the data obtained from research were compared using DUNCAN test at $P \leq 0.05$.

Results and Discussion

Fresh ear length (cm)

The results of variance analysis of fresh ear length (cm) values of sweet corn genotypes harvested at different maturation stages are given in *Table 3.*

Table 3. *Results of variance analysis of fresh ear length (cm) values of sweet corn genotypes harvested at different maturation stages*

Variation sources	Sum of Squares	Degrees of freedom	Mean Squares	F
Replicates	0.608	2	0.304	1.747ns
Genotype (G)	125.291	4	31.323	87.746**
Error1	5.712	16	0.357	
Harvest maturation stage (H)	31.516	5	6.303	8.694**
G*H	43.029	20	2.151	2.968**
Error2	72.499	100	0.725	
General	395.366	179		

*: $P \leq 0.05$, **: $P \leq 0.01$, ns: no significant

According to the results of analysis of variance, it was determined that variety, harvest maturation stage and variety*harvest maturation stage interaction were statistically significant ($P \leq 0.01$) (*Table 3*).

The highest fresh ear length was determined in Jubile (20.4 cm) variety, and the lowest fresh ear length was determined in Baron (18.5 cm). However, Vega, Jubile and

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GSS-5649 genotypes take placed in the same statistical group. The fresh ear length is a feature originating from the genetic characteristics of the plants (Oktem and Oktem, 2020a).

The fresh ear lengths of the cultivars were different from each other, and the increase in the fresh ear length continued with the increase in the harvest time (*Table 4*). The lowest fresh ear length value was reached in the early milk maturation (18.9 cm), and the highest fresh ear length was reached in the middle yellow maturation (20.2 cm).

Table 4. *Fresh ear length (cm) values and multiple comparisons of sweet corn genotypes harvested at different maturation stages*

	Genotypes					
Maturation stages	**Baron**	**Vega**	**Jubile**	**GSS-5649**	**Merit**	**Mean**
Z73*	17.9 lm[†]	19.6 e-i	20.2 a-e	19.6 e-j	17.3 m	18.9 D[†]
Z75	17.8 lm	20.3 a-e	20.6 a-d	19.7 d-h	19.3 f-k	19.5 BC
Z77	18.7 jkl	20.5 a-e	20.4 a-e	20.9 ab	19.8 c-g	20.1 A
Z83	18.5 kl	20.7 abc	20.7 abc	21.0 a	18.7 I-l	19.9 AB
Z85	19.1 g-k	20.8 ab	20.1 a-f	20.0 b-f	20.2 a-e	20.2 A
Z87	18.8 h-k	19.7 d-h	20.1 a-f	20.7abc	17.4 m	19.3 CD
Mean	18.5 B	20.3 A	20.4 A	20.3 A	18.8 B	19.6

[†]: There is no significant difference at the 5% level between the averages shown in the same letter group in the same column according to Duncan test.
*: Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, and Z87: late yellow maturation

At the variety*harvest maturation stage interaction, the highest fresh ear length was obtained from GSS-5649 sweet corn variety at the early yellow maturation stage as 21 cm while the lowest value was seen at Merit variety at the early milk maturation stage as 17.3 cm (*Fig. 1*).

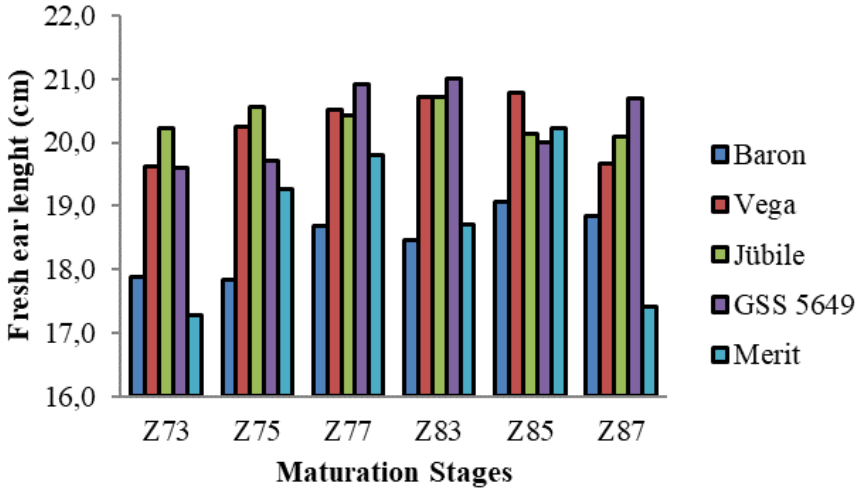

Figure 1. *Fresh ear length of sweet corn genotypes harvested at different maturation stages. Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation. Z83: early yellow maturation, Z85: middle yellow maturation, Z87: late yellow maturation*

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Findings were supported by some researchers. Szymanek (2009) stated that fresh ear length was between 20 and 23 cm. Budak and Kinaci (2012) found that the fresh ear length was between 18.7 and 21.2 cm. Sonmez et al. (2013) emphased that fresh ear length changed between 21.6-22.3 cm, while Kula and Karadogan (2017) stated that it ranged between 10.2 and 14.0 cm. Subaedah et al. (2021) reported that the fresh ear length in sweet corn varies between 25.33 and 28.08 cm, which is higher than our findings.

Fresh ear diameter (mm)

According to the results of the analysis of variance of fresh ear diameter, it was determined that there were a statistically significant (P≤0.01) differences at variety, harvest maturation stage and variety*harvest maturation stage interaction (*Table 5*).

Table 5. *Analysis of variance results of fresh ear diameter (mm) values of sweet corn genotypes harvested at different maturation stages*

Variation sources	Sum of Squares	Degrees of freedom	Mean Squares	F
Replicates	12.085	2	6.043	7.616ns
Genotype (G)	635.459	4	158.865	69.283**
Error1	36.688	16	2.293	
Harvest maturation stage (H)	1395.722	5	279.144	152.727**
G*H	108.055	20	5.403	2.956**
Error2	182.773	100	1.828	
General	3223.186	179		

* : P≤0.05, **: P≤0.01, ns: no significant

The highest fresh ear diameter was found in GSS-5649 (43.3 mm) variety, and the lowest fresh ear diameter was found in Jubile (37.6 mm) variety. It was observed that the fresh ear diameter increased with the delay of the harvest time.

The lowest fresh ear diameter data was found in the early milk maturation period (35.5 mm), and the highest fresh ear diameter data was determined in the middle yellow maturity period.

It has been reported that stem thickness increases depending on the presence of nutrients and its use by plants (Oktem and Oktem, 2020b). Stem diameter values were lower in harvests made in early maturation periods, since dry matter accumulation in the grain was less. Since the amount of dry matter accumulated in the grain increased during the late ripening periods, the ear thickness increased.

According to variety*harvest maturation stage interaction, GSS-5649 sweet corn variety gave the highest fresh ear diameter (45.7 mm) at the early yellow maturation stage the whereas the lowest value was found at Jubile variety (31.5 mm) at the early milk maturation stage (*Fig. 2, Table 6*).

Similar to the research findings, Oktem and Oktem (2006) reported that the ear diameter ranged from 37.87 to 47.45 mm, Idikut et al. (2016) stated that it varies between 38.65 – 45.56 mm. Lower than our findings, Panahi et al. (2010) reported ear diameter values between 30.1 and 40.1 mm, while Alan et al. (2011) reported higher ear diameter values with 49.37-54.54 mm and Can and Akman (2014) with 43.0-46.9 mm. Szymanek (2009) stated that ear diameter was between 41 and 49 mm.

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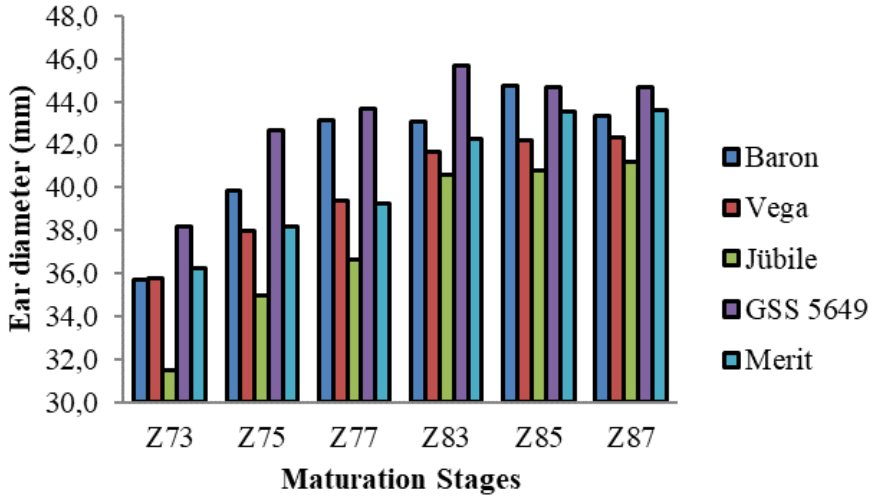

Figure 2. *Ear diameter values of sweet corn genotypes harvested at different maturation stages. Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, Z87: late yellow maturation*

Table 6. *Fresh ear diameter (mm) values and multiple comparisons of sweet corn genotypes harvested at different maturation stages*

	Genotypes					
Maturation stages	**Baron**	**Vega**	**Jubile**	**GSS-5649**	**Merit**	**Mean**
Z73*	35.7 mn	35.8 mn	31.5 o	38.2 k	36.3 mn	35.5 D†
Z75	39.8 ij	38.0 kl	35.0 n	42.7 def	38.2 k	38.7 C
Z77	43.2 cde	39.4 jk	36.6 lm	43.7 bcd	39.3 jk	40.4 B
Z83	43.1 de	41.7 e-h	40.6 hij	45.7 a	42.3 d-g	42.7 A
Z85	44.8 ab	42.2 d-g	40.8 g-j	44.7 abc	43.5 bcd	43.2 A
Z87	43.4 bcd	42.3 d-g	41.2 f-i	44.7 abc	43.6 bcd	43.0 A
Mean	41.7 B	39.9 C	37.6 D	43.3 A	40.5 C	40.6

†: There is no significant difference at the 5% level between the averages shown in the same letter group in the same column according to Duncan test.
*: Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, and Z87: late yellow maturation

Kernel number of ear (number ear^{-1})

Analysis of variance results showed that the differences between variety, harvest maturation stage and variety*harvest maturation stage interaction were determined to be statistically significant (P≤0.01) (*Table 7*).

The highest kernel number of ear value was observed in GSS-5649 (596.3 number), and the lowest kernel number of ear value was observed in Baron (415.0 number). Generally, the number of grains on the cob varies depending on the cob length. As the cob length increases, the number of grains in the cob also increases. The long cob has more grains than the short cob.

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Table 7. *Analysis of variance results of kernel number of ear values of sweet corn genotypes harvested at different maturation stages*

Variation sources	Sum of Squares	Degrees of freedom	Mean Squares	F
Replicates	3423.926	2	1711.963	45.583ns
Genotype (G)	620546.412	4	155136.603	421.590**
Error1	5887.670	16	367.979	
Harvest maturation stage (H)	72969.852	5	14593.970	54.120**
G*H	111671.051	20	5583.553	20.706**
Error2	26965.817	100	269.658	
General	1196643.97	179		

* : P≤0.05, **: P≤0.01, ns: no significant

When the harvest time delayed, the kernel number of ear first increased and then remained stable (*Table 8*). The lowest kernel number of ear value was reached in the early milk maturation period (475.9 number), and the highest kernel number of ear value was found in the late milk maturation period (540.2 number).

Table 8. *Kernel number of ear (number) values and multiple comparisons of sweet corn genotypes harvested at different maturation stages*

	Genotypes					
Maturation stages	**Baron**	**Vega**	**Jubile**	**GSS-5649**	**Merit**	**Mean**
Z73*	384.1 s	494.2 m-o	497.9 mn	539.5 gh	463.9 pq	475.9 D†
Z75	393.3 s	490.3 no	524.3 h-l	580.9 d	575.6 de	512.9 C
Z77	413.6 r	534.0 g-j	501.7 l-n	645.2 a	606.6 c	540.2 A
Z83	419.6 r	537.0 ghi	517.6 jkl	628.8 ab	547.7 fg	530.1 B
Z85	457.0 q	486.3 no	519.5 i-l	562.4 d-f	561.4 ef	517.3 C
Z87	422.2 r	511.7 k-m	512.1 k-m	621.1 bc	478.6 op	509.1 C
Mean	415.0 D	508.9 C	512.2 C	596.3 A	539.0 B	514.3

†: There is no significant difference at the 5% level between the averages shown in the same letter group in the same column according to Duncan test.
*: Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, and Z87: late yellow maturation

At the variety*harvest maturation stage interaction, the highest kernel number of ear value obtained from GSS-5649 sweet corn variety as 645.2 numbers at the late milk maturation stage while the lowest kernel number of ear value was found at Baron variety as 384.1 number at early milk maturation stage (*Fig. 3*). Environmental conditions and genetic factors affect the number of grains on the ear (Ozel and Oktem, 2021).

Parallel to the results of the research, some researchers stated that the number of grains per ear varied between 531.3 and 749.9 number (Oktem and Oktem, 2006), 410.3 and 536.9 (Atakul, 2011), 510.9 and 573.9 (Can and Akman, 2014).

While some researchers stated lower grain count values with 263.3-441.6 pieces (Bozkurt and Karadogan, 2017), 249.1- 420.0 pieces (Kula and Karadogan, 2017), some

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others indicate higher grain count values on the ear with 685-930 pieces (Alan et al., 2011), 498.31-518.88 pieces (Inan, 2019).

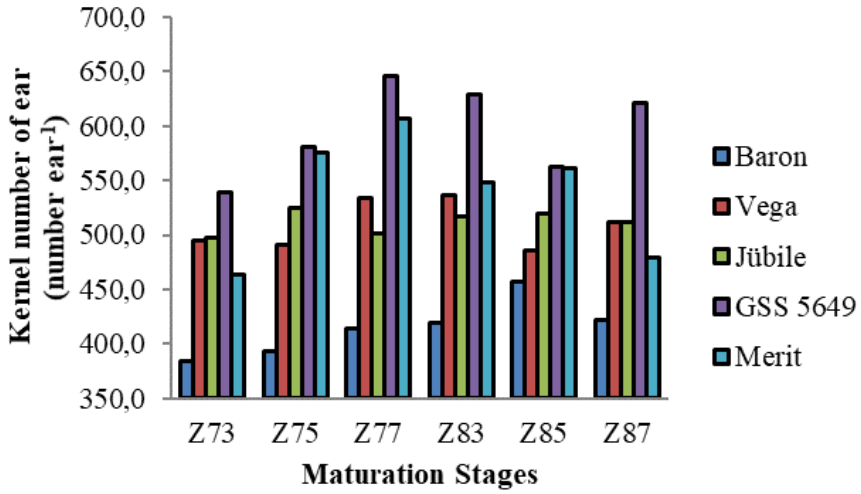

Figure 3. *Kernel number of ear (number) values of sweet corn genotypes harvested at different maturation stages. Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, Z87: late yellow maturation*

Fresh kernel weight of ear (g ear^{-1})

At the performed variance analysis, differences between cultivars, harvest maturation stage and cultivar*harvest maturation stage interaction were statistically significant (P≤0.01) (*Table 9*).

Table 9. *Analysis of variance results of fresh kernel weight of ear values of sweet corn genotypes harvested at different maturation stages*

Variation sources	Sum of Squares	Degrees of freedom	Mean Squares	F
Replicates	13.329	2	6.665	0.060ns
Genotype (G)	90766.528	4	22691.632	1390.722**
Error1	261.063	16	16.316	
Harvest maturation stage (H)	229357.557	5	45871.511	1507.785**
G*H	17174.040	20	858.702	28.225**
Error2	3042.311	100	30.423	
General	396730.112	179		

* : P≤0.05, **: P≤0.01, ns: no significant

The highest fresh kernel weight of ear was determined in GSS-5649 (187.4 g ear^{-1}) variety, and the lowest fresh kernel weight of ear was determined in Jubile (124.6 g ear^{-1}) variety (*Table 10*). This result is consistent with the previous studies that reported differences kernel weight of ear values in corn plant from various genotypes (Oktem et al., 2004; Subaedah et al., 2016; Khan et al., 2017).

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Table 10. *Fresh kernel weight of ear (g) values and multiple comparisons of sweet corn genotypes harvested at different maturation stages*

	Genotypes					
Harvest time	**Baron**	**Vega**	**Jubile**	**GSS-5649**	**Merit**	**Mean**
Z73*	73.03 r	74.03 r	60.76 s	114.9 n	69.36 r	78.4 E†
Z75	103.2 p	106.3 op	83.93 q	159.3 hij	109.9 no	112.5 D
Z77	178.8 e	165.7 fg	149.8 k	230.6 a	164.5 gh	177.9 A
Z83	161.2 g-j	170.8 f	129.5 m	224.0 b	151.2 k	167.3 B
Z85	140.6 l	158.0 ij	159.0 hij	188.0 d	161.8 ghi	161.5 C
Z87	131.7 m	155.7 ijk	164.5 gh	207.5 e	155.3 jk	162.9 C
Mean	131.4 D	138.4 B	124.6 E	187.4 A	135.3 C	143.4

†: There is no significant difference at the 5% level between the averages shown in the same letter group in the same column according to Duncan test.
*: Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, and Z87: late yellow maturation

With the delay of the harvest time, the fresh kernel weight of ear increased first, but decreased in the later harvest periods. The lowest fresh ear kernel weight was determined in the early milk maturation period (78.4 g ear^{-1}), and the highest fresh ear kernel weight value was found in the late milk maturation period (177.9 g ear^{-1}).

Since the dry matter accumulation in the grain was lower in the early ripening periods, the grain weight was lower on the ear.

In terms of variety*harvest maturation stage interaction, GSS-5649 sweet corn variety gave the highest kernel weight of ear value (230.6 g) at the late milk maturation stage while the lowest kernel weight of ear value was determined from Jubile sweet corn variety (60.76 g) at early milk maturation stage (*Fig. 4*). Budak and Kinaci (2012) stated that the grain weight on the ear varied between 188.8 - 277.7 g ear^{-1}, Ozerkisi (2016) changed between 113.9 - 153.5 g ear^{-1} and Albayrak (2013) 106.1 g ear^{-1}.

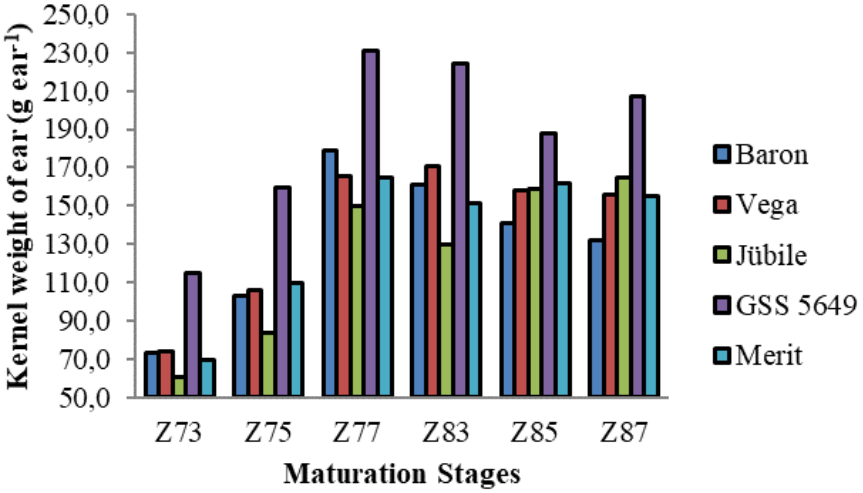

Figure 4. *Kernel weight of ear (g) values of sweet corn genotypes harvested at different maturation stages. Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, Z87: late yellow maturation*

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Fresh single ear weight (g)

In terms of fresh single ear weight, it was determined that the difference between cultivar, harvest maturation stage and cultivar*harvest maturation stage interactions was statistically significant (P≤0.01) (*Table 11*).

Table 11. *Analysis of variance results of fresh single ear weight values of sweet corn genotypes harvested at different maturation stages*

Variation sources	Sum of Squares	Degrees of freedom	Mean Squares	F
Replicates	89.315	2	44.658	0.303ns
Genotype (G)	113907.762	4	28476.941	322.941**
Error1	1410.881	16	88.180	
Harvest maturation stage (H)	147600.012	5	29520.002	571.705**
G*H	23837.626	20	1191.881	23.083**
Error2	5163.499	100	51.635	
General	385540.562	179		

* : P≤0.05, **: P≤0.01, ns: no significant

The highest fresh single ear weight was found in GSS-5649 variety with 247.7 g, and the lowest fresh single ear weight was found in Jubile variety with 173.9 g (*Table 12*). Fresh single ear weight also showed wide genetic variation and indicated the diverse nature of the genotypes. Several researchers have reported the existence of genetic variation for ear weight among various sweet corn hybrids (Oktem and Oktem, 2006; Khanduri et al., 2011; Solomon et al., 2012; Rosa, 2014).

Table 12. *Fresh single ear weight (g) values and multiple comparisons of sweet corn genotypes harvested at different maturation stages*

	Genotypes					
Maturation stages	**Baron**	**Vega**	**Jubile**	**GSS-5649**	**Merit**	**Mean**
Z73*	150.4 lm	154.8 kl	130.2 n	202.4 g	133.1 n	154.2 E†
Z75	192.6 h	161.0 jk	153.1 kl	237.9 cd	186.3 h	186.2 C
Z77	172.6 i	185.5 h	143.2 m	233.5 d	165.4 ij	180.0 D
Z83	202.2 g	245.8 c	193.3 h	285.5 a	218.2 e	229.0 A
Z85	209.3 fg	219.2 e	211.7 ef	260.7 b	240.8 cd	228.3 A
Z87	190.7 h	219.4 e	212.1 ef	266.4 b	232.5 d	224.2 B
Mean	186.3 C	197.6 B	173.9 D	247.7 A	196.0 B	200.3

†: There is no significant difference at the 5% level between the averages shown in the same letter group in the same column according to Duncan test.
*: Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, and Z87: late yellow maturation

While the lowest fresh single ear weight values were determined in the early milk-setting period (154.2 g), the highest fresh single ear weight values were obtained in the early yellow maturity period (229.0 g). Fresh single ear weight values are found higher

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because the amount of dry matter accumulated in the grain increases in late ripening periods. Subaedah et al. (2021) reported that the highest ear weight was seen at late harvesting of 75 day after planting (372.22 g ear^{-1}).

At the variety*harvest time interaction, the highest fresh single ear weight was obtained from GSS-5649 variety at the early yellow maturation stage as 285.8 g while the lowest value was seen at Jubile variety at the early milk maturation stage as 130.2 g (*Fig. 5*).

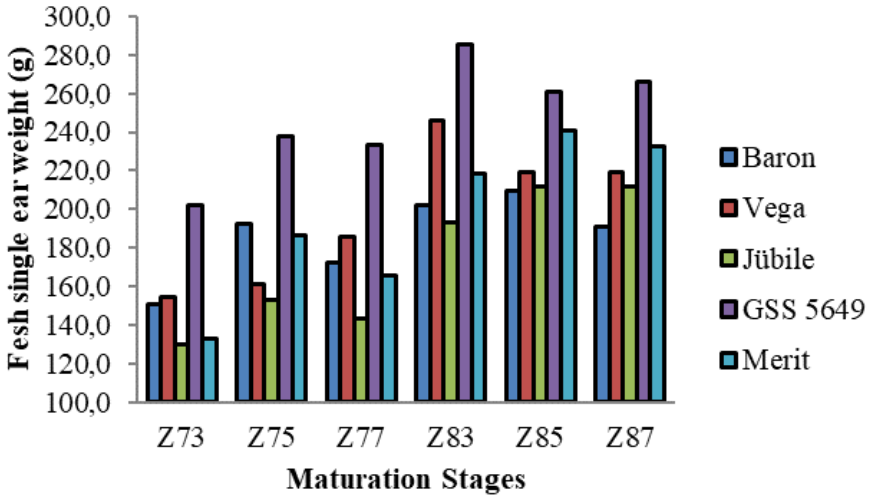

Figure 5. *Fresh single ear weight (g) values of sweet corn genotypes harvested at different maturation stages. Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, Z87: late yellow maturation*

Some researchers stated higher fresh single ear weight than our findings. Sonmez et al. (2013) reported that fresh ear weight values ranged between 358 and 384 g, Budak and Kınacı (2012) between 252.0 and 355.6 g, while Atar and Kara (2017) stated lower values with 143.0 and 169.5 g. Similar to our findings, Idikut et al. (2016) reported fresh ear weight values varying between 184.5 and 208.99 g. Subaedah et al. (2021) emphased that Bonanza variety produced the heaviest ear (374.17 g ear^{-1}), whereas the Talenta variety produced the lightest (310.83 g ear^{-1}).

Fresh ear yield (kg da^{-1})

In terms of fresh ear yield, variety, harvest maturation stage and variety*harvest maturation stage interactions were found to be statistically significant ($P \leq 0.01$) (*Table 13*). The highest fresh ear yield was determined as 1994 kg da^{-1} in GSS-5649 variety and the lowest value was found in Jubile variety with 1381 kg da^{-1} (*Table 14*).

Our findings were similar with previous studies. According to some researchers, the fresh ear yield was reported between 845 and 1651 kg da^{-1} (Aprilianti et al., 2016), between 1121 and 1912 kg da^{-1} (Bozkurt and Karadogan, 2017), between 860 and 1459 kg da^{-1} (Kula and Karadogan, 2017). Akgun et al. (2017) reported a lower fresh ear yield values as 464-490 kg da^{-1}, while Alan et al. (2011) reported higher fresh ear yield values (1756-2108 kg da^{-1}).

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Table 13. *Analysis of variance results of fresh ear yield values of sweet corn genotypes harvested at different maturation stages*

Variation sources	Sum of Squares	Degrees of freedom	Mean Squares	F
Replicates	4357.924	2	2178.962	1.807ns
Genotype (G)	8277455.442	4	2069363.860	2962.084**
Error1	11177.880	16	698.617	
Harvest maturation stage (H)	6988853.314	5	1397770.663	1214.895**
G* H	1089964.088	20	54498.204	47.368**
Error2	115052.766	100	1150.528	
General	18403368.026	179		

* : P<0.05, **: P<0.01, ns: no significant

Table 14. *Fresh ear yield values (kg da^{-1}) and multiple comparisons of sweet corn genotypes harvested at different maturation stages*

	Genotypes					
Maturation stages	**Baron**	**Vega**	**Jubile**	**GSS-5649**	**Merit**	**Mean**
Z73*	1129 op	1164 o	981 q	1622 h	1103 p	1200 F†
Z75	1462 ij	1420 kl	1216 n	1989 c	1390 l	1495 E
Z77	1627 h	1671 g	1430 jk	2120 a	1601 h	1690 C
Z83	1444 ijk	1665 g	1344 m	2078 b	1476 i	1601 D
Z85	1595 h	1794 e	1592 h	2019 c	1890 d	1778 A
Z87	1458 ijk	1730 f	1724 f	2138 a	1714 f	1753 B
Mean	1452 D	1574 B	1381 E	1994 A	1529 C	1586

†: There is no significant difference at the 5% level between the averages shown in the same letter group in the same column according to Duncan test.
*: Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, and Z87: late yellow maturation

The lowest fresh ear yield was observed in the early milk maturation period (1200 kg da^{-1}), and the highest fresh ear yield was observed in the middle yellow maturation period (1778 kg da^{-1}). Similar to the findings, it has been reported that genotypes behave differently at different harvest dates (Khanduri et al., 2011; Oktem, 2019).

With delaying of harvest time, fresh ear yield increased. It was determined that fresh ear yield increased at the harvests made in late maturation stages. Similar to our results, it was stated by some researchers that the yield increased in advanced maturation periods (Soon et al., 2004; Szymanek, 2009; Subaedah et al., 2021; Saruhan and Oktem, 2021).

Subaedah et al. (2021) also stated that fresh ear yield was ranged from 16.98 to 22.33 t ha^{-1} and delaying harvest time resulted higher yield. Szymanek (2009) emphasized that the yield increased from 15.88 to 18.64 t ha^{-1} with delaying harvest time. In addition, it was reported that the ear yield was influenced by harvest time and late harvest was the most favourable for high yield (Mehta et al., 2017).

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Fresh ear yield was lower in harvests made in early maturation periods. While the fresh ear yield is lower due to the low dry matter accumulation in the grain in the first ripening periods, it increases in the later maturation periods and reaches the highest level in the middle yellow maturation period. However, after this level, the fresh ear yield decreases due to moisture loss in the grain. However, the decrease in grain moisture causes the grains to harden and the market value of sweet corn cobs to decrease. Szymanek (2009) stated that the moisture content decreased from 77.41% to 69.83% with delayed harvest date, a decline was observed in the sweet corn quality.

According to variety*harvest maturation stage interaction, GSS-5649 sweet corn variety gave the highest fresh ear yield (2138 kg da^{-1}) at the late yellow maturation stage whereas the lowest value was found at Jubile variety (981 kg da^{-1}) at the early milk maturation stage (*Fig. 6*). Growing conditions and genotype characteristics affect the fresh ear yield (Oktem and Oktem, 2009).

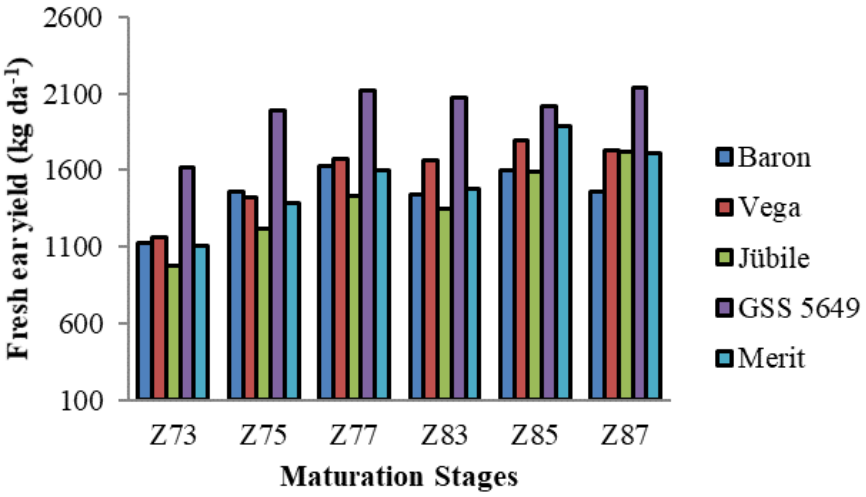

Figure 6. *Fresh ear yield (kg da^{-1}) values of sweet corn genotypes harvested at different maturation stages. Z73: early milk maturation, Z75: middle milk maturation, Z77: late milk maturation, Z83: early yellow maturation, Z85: middle yellow maturation, Z87: late yellow maturation*

Conclusion

It was determined that fresh ear yield, fresh kernel weight of single ear, fresh single ear weight and ear diameter increased at the harvests made in late maturation stages. Fresh ear yield was lower in harvests made in early maturation periods. The highest fresh ear yield was found in the middle yellow maturation period. GSS-5649 sweet corn variety gave the highest fresh ear yield (2138 kg da^{-1}) at the late yellow maturation stage whereas the lowest value was determined at Jubile variety (981 kg da^{-1}) at the early milk maturation stage.

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