Atatürk Üniversitesi Ziraat Fakültesi Dergisi
Atatürk University Journal of Agricultural Faculty

Atatürk Üniv. Ziraat Fak. Derg., 51 (3): 288-296, 2020
Atatürk Univ. J. of Agricultural Faculty, 51 (3): 288-296, 2020
ISSN: 1300-9036, E-ISSN: 2651-5016
http://dergipark.gov.tr/ataunizfd

Araştırma Makalesi / Research Article

Performance of Some Sweet Corn (*Zea mays* L. var. *saccharata*) Cultivars in High Altitude Conditions

Haluk Çağlar KAYMAK[1,*, a] Ahmet Hakan ÜRÜŞAN[2, b]
[1]Atatürk University, Agricultural Faculty, Department of Horticulture, Erzurum, Turkey
[2]Bingöl University, Vocational School of Technical Sciences, Bingöl, Turkey
*Corresponding author e-mail: hckaymak@atauni.edu.tr
doi: 10.17097/ataunizfd.704808

Geliş Tarihi (Received): 16.03.2020 Kabul Tarihi (Accepted): 21.07.2020 Yayın Tarihi (Published): 25.09.2020

ABSTRACT: This study was undertaken to determine the performance of some sweet corn (*Zea mays* L. var. *saccharata*) cultivars at different sowing dates under high altitude conditions. In this research, the seeds of 4 sweet corn cultivars (*Zea mays* L. var. *saccharata* cvs. 'Martha F_1, Vega F_1, Merit F_1 and Sunshine F_1') were used as plant material. It was determined that sowing date has a significant effect on the plant height, cob diameter and length, the number of kernels/cob, husked and de-husked cob weight, and total husked and de-husked cob yield. Due to the delay in sowing date, all examined parameters were reduced. Martha F_1 compared to the other cultivars showed the best performance in terms of total husked and de-husked cob yield. The highest total husked (17260 kg ha^{-1}) and de-husked (11818 kg ha^{-1}) cob yield were determined in cv. Martha F_1 in the first sowing date in both experiment years. In high altitude production areas such as Erzurum, sowing should be done as early as possible for high yield and quality in sweet corn. According to the results of the research, sweet corn can be produced successfully with sowing on 23 May in Erzurum. Also, all of the cultivars used in this research, especially cv. Martha F_1 can be recommended to the sweet corn producer for high yield and quality.

Keywords: High altitude, Sowing date, Variety, Yield components

Bazı Tatlı Mısır (*Zea mays* L. var. *saccharata*) Çeşitlerinin Yüksek Rakım Koşullarında Performansı

ÖZ: Bu çalışma, yüksek rakım koşullarında farklı ekim zamanlarında bazı tatlı mısır (*Zea mays* L. var. *saccharata*) çeşitlerinin performansını belirlemek amacıyla yürütülmüştür. Araştırmada, 4 adet tatlı mısır çeşidi (*Zea mays* L. var. *saccharata* cvs. 'Martha F_1, Vega F_1, Merit F_1 ve Sunshine F_1') bitkisel materyal olarak kullanılmıştır. Ekim zamanının bitki boyu, koçan büyüklüğü, koçandaki tane sayısı, koçan ağırlığı ve toplam verim üzerinde önemli bir etkisi olduğu belirlenmiştir. Ekim zamanındaki gecikmeye bağlı olarak incelenen tüm parametrelerde azalma belirlenmiştir. Martha F_1 diğer çeşitlere kıyasla hem kavuzlu hem de kavuzsuz toplam koçan verimi açısından her iki deneme yılında da en iyi performansı göstermiştir. Nitekim, en yüksek toplam kavuzlu (17260 kg ha-1) ve kavuzsuz (11818 kg ha-1) koçan verimi, her iki deneme yılında da ilk ekim tarihinde Martha F_1 çeşidinde tespit edilmiştir. Erzurum gibi yüksek rakımlı üretim alanlarında, mısırda yüksek verim ve kalite için ekim mümkün olduğunca erken yapılmalıdır. Araştırma sonuçlarına göre tatlı mısır Erzurum'da 23 Mayıs'ta yapılacak ekim ile başarılı bir şekilde üretilebilir. Ayrıca, bu araştırmada kullanılan çeşitlerin tamamı, özellikle Martha F_1 çeşidi, tatlı mısır üreticisine yüksek verim ve kalite için önerilebilir.

Anahtar Kelimeler: Yüksek rakım, Ekim zamanı, Varyete, Verim bileşenleri

INTRODUCTION

Sweet corn (*Zea mays* L. var. *saccharata*) is belonging to family Poaceae and the genus *Zea*. Although sweet corn uses and accepts as a vegetable; maize, including sweet corn, is the third most important cereal crop after rice and wheat in the world. Because of its high amount of minerals phosphorus, magnesium, iron, zinc, vitamins and antioxidants, it uses widely both in human nutrition and numerous industrial products (Welbaum, 2015; Keerthi et al., 2017). In addition, corn is divided and investigated in two groups: corn that is harvested as dried grain and corn that is harvested fresh as a vegetable. Vegetable corn includes not only sweet corn but also baby corn and roasting cobs (Rubatzky and Yamaguchi, 1997). The leader producer country of sweet corn is USA, other important producer countries are Nigeria, Mexico, Indonesia, Peru etc. (FAO, 2020).

Sweet corn is warm-season, frost sensitive and annual monocot crop. The optimum mean temperature range for high quality and yield is 21-30°C and the minimum threshold temperature for

Bu makaleye atıfta bulunmak için / To cite this article: Kaymak, H.Ç., Ürüşan, A.H., 2020. Performance of Some Sweet Corn (*Zea mays* L. var. *saccharata*) Cultivars in High Altitude Conditions. Atatürk Univ. J. of Agricultural Faculty, 51 (3): 288-296. doi: 10.17097/ataunizfd.704808

[a]ORCID: https://orcid.org/0000-0002-0836-7654 [b]ORCID: https://orcid.org/0000-0002-6726-1008

growth and development is around 10ºC. Also, cold night temperatures affect negatively plant growth and extend the time required maturity (Swiader et al., 1992). Sweet corn is harvested or sold based on brix values or moisture content but it can be generally harvested within 80-90 days (Welbaum, 2015; Dekhane and Dumbre 2017). On the other hand, sowing at the appropriate time is crucial for optimizing yields because the delay in sowing can lead to a reduction in yield, as heat accumulation over time directly affects growth and yield (Anapalli et al., 2005). It is a known fact that high yield depends on optimum sowing date and appropriate cultivar. Proper sowing date is important because of efficient sunlight for photosynthesis besides the efficient use of plant nutrients and soil moisture (Dekhane and Dumbre 2017). For this reason, sweet corn or corn growers are in a fine line between when the sowing date is too late and too early. Early or late sowing can result in lower yields; as adverse climatic conditions are likely to occur after sowing or during the growing season (Nielson et al., 2002; Rah Khosravani et al., 2017).

Fekonja et al. (2011) and Genc et al. (2013) reported that sweet corn is a new potential crop for moderate climates where additional agricultural improvements are provided due to climate changes. With the appropriate sowing date, sweet corn can be grown not only in moderate climates but also in high altitude growing areas because climatic changes such as increased average temperatures and extended vegetation period make it possible to sow corn earlier than recommended in many places (Rosa, 2014). Finally, according to the Rosa (2014) report, it can be clearly argued that the appropriate sowing date of sweet corn is one of the factors which affect both the yield and its quality. Therefore, this study was undertaken to determine the performance of some sweet corn (*Zea mays* L. var. *saccharata*) cultivars at different sowing dates under high altitude conditions.

MATERIAL AND METHOD

The field experiments were carried out in the experimental fields of Plant Production, Application and Research Centre, Atatürk University, Erzurum (40° 57’ and 39° 10’N; 40° 15’ and 42° 35’E; 1850 m above sea level), during 2011 and 2012. Detailed information on the air temperature of the experimental area during the growth period was given in Figure 1. The soil of the experimental area in 2011-2012 had a loamy texture having 32.40% sand, 41.77% silt and 24.73% clay. Some of the soil chemical characteristics were as follows: soil pH 7.72 and 7.56; organic matter 2.3 and 2.6%; available P_2O_5 119.1 and 138.5 kg ha^{-1}; exchangeable K 1090.7 and 1540.6 kg ha^{-1} and lime 0.65% and 0.22% in 2011 and 2012, respectively. The soil temperature varied between 15.9 and 19.7ºC at sowing dates at a depth of 5 cm in the experiment years.

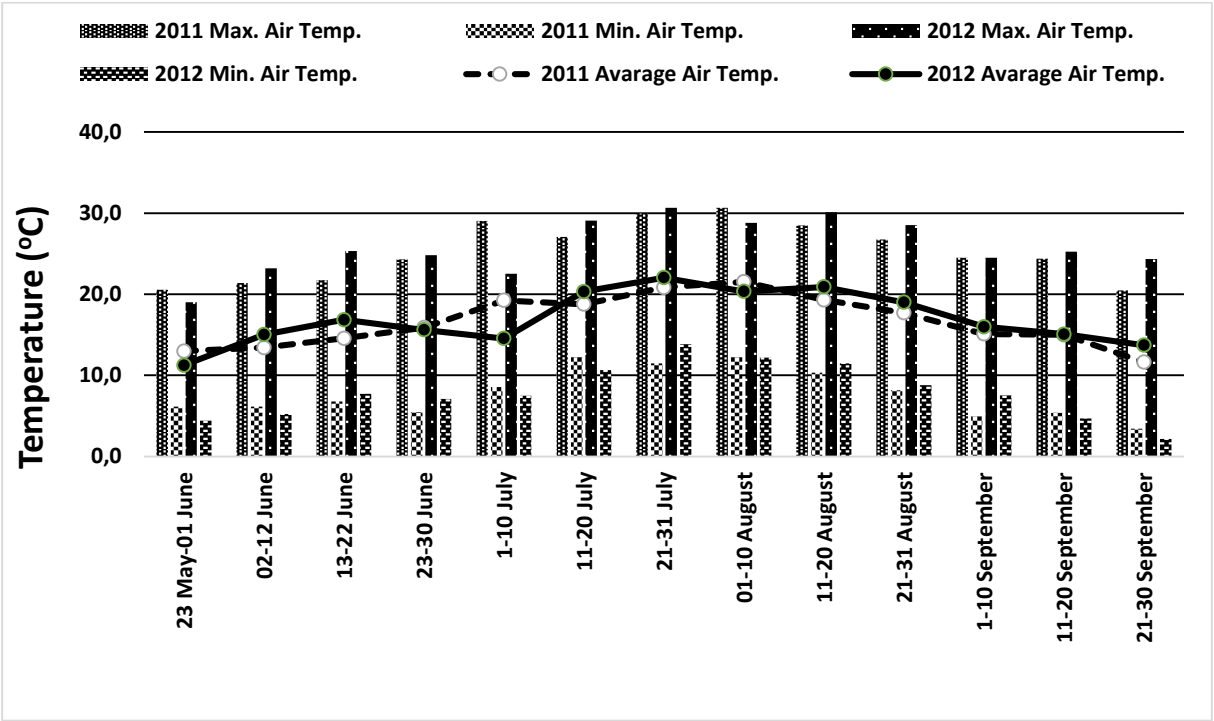

Figure 1. The maximum, minimum and average air temperature (˚C) of the experimental area during the May-September period.

In this research, the seeds of 4 sweet corn cultivars (*Zea mays* L. var. *saccharata* cvs. 'Martha F_1, Vega F_1, Merit F_1 and Sunshine F_1') were used and supplied by the Turkish seed company, MayAgro Seed Corporation.

Seeds were sown three times in 10 days intervals (23 May, 02 June and 12 June), to investigate the effect of temperature in high altitude conditions. Seeds were sown on plots of 9 m^2 at the depth of 4-5 cm, in rows 300 cm long, at a distance between rows of 70 cm and between plants of 20 cm. In addition, thinning was made by hand when seedlings were at the 3-4 leaf stage, one plant with the best condition was kept and the others were eliminated (Kharazmshahi et al., 2015). The plants were irrigated twice a week with furrow irrigation and the plant care practices were irrespectively applied to the plants in each plot.

Before sowing, the soil was fertilized by 250 kg ha^{-1} N and 100 kg ha^{-1} P_2O_5 as urea and triple super phosphate, respectively. All of the P_2O_5 and 100 kg ha^{-1} N fertilizer were applied with sowing and the remaining part of N (150 kg ha^{-1}) was given when the plants reached 30-40 cm plant height (Turgut and Balcı 2002).

In the experiment, the cobs were harvested by hand while the tassels dried, about 75-80 days after sowing. Plant height (cm), cob diameter (mm) and length (cm), the number of kernels/cob, husked and de-husked cob weight (g), and total husked and de-husked cob yield (kg ha^{-1}) were determined. Observations were made and recorded on 12 plants selected randomly from plants in each plot.

A completely randomized block design with 3 replications was used as the experimental design. ANOVA was applied to the data determined in the experiment and Duncan's multiple range test was used to compared the differences between means.

RESULTS AND DISCUSSION

The plant height of sweet corn cultivars varied significantly ($P < 0.01$) according to the sowing dates (Table 1). It was determined that early sowing has a significant effect on the plant height. Thus, it was found that the highest plant height (173.3 cm, 170.1 cm, and 171.7 cm) was recorded in cv. Merit F_1 in 2011, 2012 and the mean of 2011-2012, respectively from the first sowing date (23 May). The shortest plant height was determined in the last sowing date (12 June) for both experiment years, and the shortest plant height was determined in cv. Vega F_1 (34.9 cm) in 2011. In other words, delaying in sowing date decreased plant height. Dekhane et al. (2017) indicated that the early sowing significantly affected the plant height and higher plant height was obtained from early sowings. Abdel-Rahman et al. (2001) and Sarvari et al. (2007) reported similar results. The mentioned studies above also confirmed the results of this study.

Table 1. The effect of sowing dates on plant height of sweet corn cultivars (cm)

Cultivars	Sowing Date	2011	2012	Mean (Years)	Mean
Martha F_1	23 May	126.1 a**	122.1 a**	124.1 a**	91.3 B**
	2 June	105.3 b	107.1 b	106.2 b	
	12 June	44.2 c	42.7 c	43.5 c	
Vega F_1	23 May	112.6 a**	117.2 a**	114.9 a**	85.0 B
	2 June	104.8 a	105.2 b	105.0 b	
	12 June	34.9 b	35.4 c	35.2 c	
Merit F_1	23 May	173.3 a**	170.1 a**	171.7 a**	121.0 A
	2 June	146.5 b	148.4a	147.4 b	
	12 June	43.7 c	44.1 b	43.9 c	
Sunshine F_1	23 May	116.3 a**	118.4 a**	117.4 a**	89.9 B
	2 June	113.2 a	110.9 a	112.0 a	
	12 June	40.9 b	39.9 b	40.4 b	
Mean (Sowing dates)	23 May	132.1	132.0	132.0 A**	
	2 June	117.4	117.9	117.7 B	
	12 June	40.9	40.6	40.7 C	

**Significant at $P < 0.01$

The cob length and cob diameter of different sowing dates for all cultivars used in this study are shown in Table 2. The highest cob length (21.1 cm) was recorded from 23 May sowing in cv. Vega F_1 for both experiment years and in cv. Sunshine F_1 in 2012 from 2 June sowing whereas the lowest from 12 June (18.5 cm) sowing. The cob diameter was changed between 40.5 mm and 51.6 mm in 2011, from 12 June and 23 May sowings, respectively. In addition, sowing dates did not significantly affect the cob length, except for cvs. Martha F_1 and Merit F_1 in 2011. On the other hand, due to the delay in sowing

date, the diameter of the cobs decreased. According to the report of Dekhane and Dumbre (2017), cob length changed according to the cultivars and sowing dates. Their report indicated that the cob length ranged between 19.1 and 20.4, and 17.7 and 21.8 in cultivars and sowing dates, respectively. Shaheenuzzamn et al. (2015) reported that sowing date significantly affected the cob length and diameter. Also reported that cob diameter changed between 4.09 cm and 4.44 cm. Similarly, Rosa (2014) declared that the effect of the sowing date on cob length and diameter varied according to cultivars, sowing dates and also the experiment years, and the highest cob length and diameter were 20.7 cm and 4.9 cm, respectively. The results of this work are similar and confirmative with the mentioned studies.

Table 2. The effect of sowing dates on cob length (cm) and diameter (mm) of sweet corn cultivars

Cultivars	Sowing Date	2011	2012	Mean (Years)	Mean
		Cob length (cm)			
Martha F_1	23 May	19.6 a**	20.4^{NS}	20.0 a*	
	2 June	19.7 a	20.6	20.1 a	19.8 B*
	12 June	18.5 b	20.1	19.3 b	
Vega F_1	23 May	21.1^{NS}	21.1^{NS}	21.1^{NS}	
	2 June	21.0	20.9	20.9	20.7 A
	12 June	19.9	20.1	20.0	
Merit F_1	23 May	19.7 a*	20.5^{NS}	20.1^{NS}	
	2 June	18.9 b	20.6	19.8	19.8 B
	12 June	19.0 ab	20.3	19.6	
Sunshine F_1	23 May	20.2^{NS}	20.5^{NS}	20.3^{NS}	
	2 June	20.5	21.1	20.8	20.3 A
	12 June	19.8	20.0	19.9	
Mean (Sowing dates)	23 May	20.2	20.6	20.4 A*	
	2 June	20.0	20.8	20.4 A	
	12 June	19.3	20.1	19.7 B	
		Cob diameter (mm)			
Martha F_1	23 May	51.6 a**	49.4^{NS}	50.5 a**	
	2 June	49.4 a	50.2	49.8 a	47.8^{NS}
	12 June	40.5 b	45.8	43.2 b	
Vega F_1	23 May	49.3 a**	49.3 a**	49.3 a**	
	2 June	48.6 a	48.9 a	48.8 a	46.9
	12 June	40.6 b	44.8 b	42.7b	
Merit F_1	23 May	48.7 a**	51.2 a*	49.9 a**	
	2 June	47.6 a	46.9 b	47.3 b	47.1
	12 June	42.6 b	45.4 b	44.0 c	
Sunshine F_1	23 May	47.5 a*	49.3^{NS}	48.4^{NS}	
	2 June	47.1 a	48.0	47.6	47.0
	12 June	41.0 b	49.0	45.0	
Mean (Sowing dates)	23 May	49.3	49.8	49.6 A**	
	2 June	48.2	48.5	48.4 B	
	12 June	41.2	46.3	43.7 C	

**Significant at $P < 0.01$, *Significant at $P < 0.05$, NS: Non significant at $P < 0.05$.

As it is shown in Table 3, the number of kernels/cob of sweet corn cultivars were varied according to the cultivars, and differences between sowing dates were statistically significant ($P < 0.01$) in 2011 and 2012. Delaying sowing date decreased the number of kernels/cob of all sweet corn cultivars in both experiment years. While the effect of sowing date on the number of kernels/cob varied with cultivars, the highest number of kernels/cob (751.2) was determined in cv. Martha F_1 in 2011 in the first sowing date. The lowest number of kernel/cob (432.0) was found in Merit F_1 in 2012 in the last sowing date. Similar results were also reported by Khan et al. (2009) and reported that delaying sowing date would lead to a low row number and kernel numbers. Dekhane and Dumbre (2017) also reported that the number of kernels in the cob decreased due

to the delay in sowing date. According to Tuncay et al. (2005) report the number of kernels in cobs also varies according to the size of the cobs. The results of this work are verified by the mentioned works above.

Table 3. The effect of sowing dates on the total number of kernels/cob of sweet corn cultivars

Cultivars	Sowing Date	2011	2012	Mean (Years)	Mean
Martha F_1	23 May	751.2 a**	720.5 a**	735.8a**	666.5 A**
	2 June	735.3 a	715.2 a	725.3 a	
	12 June	536.3 b	540.3 b	538.3 b	
Vega F_1	23 May	653.3 a**	727.1 a**	690.2 a**	627.2 B
	2 June	693.3 a	706.4 a	699.9 a	
	12 June	528.5 b	454.9 b	491.7 b	
Merit F_1	23 May	623.9 b**	661.0 a**	642.4 b**	607.0 B
	2 June	689.9 a	708.9 a	699.4 a	
	12 June	526.7 c	432.0 b	479.3 c	
Sunshine F_1	23 May	642.8 b**	668.4 b**	655.6 b**	631.0 B
	2 June	727.1 a	729.2 a	728.1 a	
	12 June	536.0 c	482.6 c	509.3 c	
Mean (Sowing dates)	23 May	667.8	694.2	681.0 B**	
	2 June	711.4	714.9	713.2 A	
	12 June	531.9	477.4	504.6 C	

**Significant at $P < 0.01$

The effect of the sowing date on husked cob weight and de-husked cob weight of sweet corn cultivars was shown in Table 4. There were statistically significant differences between the cob weight of sweet corn cultivars ($P < 0.01$) and sowing dates ($P < 0.01$). The highest husked cob weight was obtained from cv. Martha F_1 (372.8 g) in the first sowing date in 2011. While in the case of pooled cv. Martha F_1 gave significantly higher husked cob weight (263.8 g) over the other three cultivars. Husked cob weight was also found significant with different sowing dates. The first sowing date (23 May) had significantly high husked cob weight in 2011, 2012, and in pooled data. The de-husked cob weight was varied according to the cultivars and differences between sowing dates were statistically significant ($P < 0.05$ and $P < 0.01$), except for Martha F_1, Merit F_1 and Sunshine F_1 in 2012. It was obtained that sowing dates have a significant effect on the de-husked cob weight. Thus, it was found that significantly higher de-husked cob weight was recorded in cvs. Vega F_1 and Merit F_1 in 2011. The de-husked cob weight was changed between 104.1 g (Martha F_1) and 232.7 g (Vega F_1) in 2011 and 2012.

The effect of the sowing date on sweet corn cob weight varied according to the experiment years and cultivars. Also, the findings of Maryam et al. (2011) indicated that an appropriate sowing date will give the highest cob weight than late sowing. Similarly, Dekhane and Dumbre (2017) reported that early sowings gave higher cob weight than late sowings. On the other hand, Turgut and Balcı (2002) and Eşiyok and Bozokalfa (2005) reported that cob weight changed according to the sowing dates and delaying sowing date increased cob weight of all sweet corn cultivars in Bursa and Izmir conditions, respectively. However, according to the results of this study, the weight of cobs decreased due to delayed sowing date. Considering that the cities of Bursa and Izmir are at sea level, this may be due to the fact that Erzurum is at an altitude of 1850 meters above sea level. In other words, low night temperatures, short vegetation period, and low average temperatures of the experimental area at high altitudes may have caused a reduction in cob weight. As a matter of fact, while the minimum temperatures ranged between 2.2°C and 13.9°C, the mean temperatures varied from 11°C to 21°C in the experimental area in both experiment years (Fig. 1).

Table 4. The effect of sowing dates on husked cob weight and de-husked cob weight of sweet corn cultivars (g)

Cultivars	Sowing Date	2011	2012	Mean (Years)	Mean
		Husked cob weight (g)			
Martha F_1	23 May	372.8 a**	242.8^{NS}	307.8 a**	263.8 A**
	2 June	369.7 a	247.0	308.4 a	
	12 June	160.5 b	190.0	175.3 b	
Vega F_1	23 May	339.9^{NS}	227.8 a*	283.8 a**	261.1 A
	2 June	364.8	205.3 a	285.0 a	
	12 June	326.5	102.8 b	214.7 b	
Merit F_1	23 May	284.7^{NS}	214.2^{NS}	249.5^{NS}	228.5 B
	2 June	278.4	183.0	230.7	
	12 June	234.4	176.1	205.3	
Sunshine F_1	23 May	346.3 a**	204.9^{NS}	275.6 a**	243.3 AB
	2 June	336.3 a	217.4	276.9 a	
	12 June	188.9 b	165.8	177.3 b	
Mean (Sowing dates)	23 May	335.9	222.4	279.2 A**	
	2 June	337.3	213.2	275.3 A	
	12 June	227.6	158.7	193.1 B	
		De-husked cob weight (g)			
Martha F_1	23 May	221.3 a**	166.2^{NS}	193.7 a**	166.5 A**
	2 June	207.6 a	164.1	185.9 a	
	12 June	104.1 b	135.7	119.9 b	
Vega F_1	23 May	206.1 b*	164.8 a**	185.4 a*	174.4 A
	2 June	232.7 ab	146.9 a	189.8 a	
	12 June	227.3 a	68.6 b	148.0 b	
Merit F_1	23 May	188.4^{NS}	144.2^{NS}	166.3^{NS}	150.7 B
	2 June	172.1	115.2	143.7	
	12 June	151.0	132.9	142.0	
Sunshine F_1	23 May	200.9 a*	159.0^{NS}	180.0 a**	157.4 B
	2 June	195.8 a	152.0	173.9 a	
	12 June	112.5 b	124.1	118.3 b	
Mean (Sowing dates)	23 May	204.2	158.5	181.4 A**	
	2 June	202.1	144.6	173.3 A	
	12 June	148.8	115.3	132.1 B	

**Significant at $P < 0.01$, *Significant at $P < 0.05$, NS: Non significant at $P < 0.05$.

Total husked and de-husked cob yield of sweet corn cultivars was affected by sowing date, and statistically significant ($P < 0.01$) differences between sweet corn cultivars and sowing dates were determined in both experiment years (Table 5). The highest total husked and de-husked cob yield was determined on 23 May and 02 June sowings, while the lowest total yield was obtained from the last sowing date (12 June) in both experiment years. The results indicated that both total husked and de-husked cob yield of sweet corn cultivars, especially Merit F_1, decreased due to delayed sowing dates in 2011 and 2012. Martha F_1 compared to the other cultivars showed a better performance in terms of total husked and de-husked cob yield. The highest total husked (17260 kg ha^{-1}) and de-husked (11818 kg ha^{-1}) cob yield were determined in cv. Martha F_1 in the first sowing date in both experiment years. In addition, when general means of sowing dates were taken into consideration, it was clearly said that delaying in the sowing dates decreased both total husked and de-husked cob yield (Table 5).

Dekhane et al. (2017) reported that the yield of sweet corn changed according to the cultivars and sowing dates. Therefore, selecting of high-quality cultivars and sowing at the appropriate time is very critical and important for the optimization of sweet corn yield. Similarly, Annapalli et al. (2005) and Khan et al. (2009) declared that the yield can be increased by using high yielding cultivars and sowing at the appropriate time. On the other hand, it has been previously mentioned that low night temperatures, short vegetation period and low average temperatures adversely affect the weight of the sweet corn cobs at high altitude conditions. A similar situation can be said for the total yield of sweet corn cultivars used in this work. Depending on the delay in sowing date, the reduction in the weight of the sweet corn cobs reduced the yield. Also, it was stated that the effects of climatic factors such as photoperiod and

temperature in different sowing dates on the growth and development of corn may vary. It was also reported that the highest yield was obtained from the early sowings (Dekhane and Dumbre, 2017). Similarly, Dekhane et al. (2017) argue that when sowing date was delayed, sweet corn yield decreased. In addition, early sowings were suggested for successful sweet corn production in the hilly areas (Shaheenuzzamn et al., 2015). Therefore, in order to make the best use of soil moisture, plant nutrients, and solar radiation and to obtain a high-quality yield, optimum sowing date should be determined (Keerthi et al, 2017). Withal, Shaheenuzzamn et al. (2015) reported that the highest yield (8.60 t ha^{-1}) was obtained from the first sowing in the hilly region. Sugar-75 sweet corn cultivar was reported to have the highest yield (2616 kg ha-1) when sowing early (Dekhane and Dumbre, 2017). In previous studies, it is clearly seen by different researchers that the yield of sweet corn varies according to cultivars and sowing dates, and the highest yield is obtained from early sowings. Similarly, while the yield varied according to cultivars and sowing dates, the highest yield was obtained from early sowings in this study. The results obtained from this research are consistent with and supported by the findings of previous researchers.

Table 5. The effect of sowing dates on total husked and de-husked cob yield of sweet corn cultivars (kg ha^{-1})

Cultivars	Sowing Date	2011	2012	Mean (Years)	Mean
			Husked cob yield (kg ha^{-1})		
	23 May	14763 b**	17260 a**	16012 a**	
Martha F_1	2 June	17462 a	15548 a	16505 a	12535^{NS}
	12 June	2143 c	8033 b	5088 b	
	23 May	13982 a**	13711 a**	13847 a**	
Vega F_1	2 June	13654 a	12937 a	13296 a	10227
	12 June	4243 b	2835 b	3539 b	
	23 May	11533 a**	$15620^{N.S.}$	13577 a**	
Merit F_1	2 June	13797 a	13199	13498 a	11095
	12 June	1802 b	10559	6181 b	
	23 May	13418 a**	12973 ab*	13196 a**	
Sunshine F_1	2 June	16718 a	16614 a	16666 a	11586
	12 June	2548 b	7242 b	4895 b	
Mean	23 May	13424	14891	14158 A**	
(Sowing dates)	2 June	15408	14575	14992 A	
	12 June	2684	7167	4926 B	
			De-husked cob yield (kg ha^{-1})		
	23 May	8783 a**	11818 a*	10300 a**	
Martha F_1	2 June	9813 a	10328 a	10070 a	7971^{NS}
	12 June	1390 b	5694 b	3542 b	
	23 May	8452 a**	9940 a**	9196 a**	
Vega F_1	2 June	8712 a	9253 a	8982 a	6904
	12 June	3221 b	1847 b	2534 b	
	23 May	7630 a**	10603NS	9117 a*	
Merit F_1	2 June	8437 a	8315	8376 a	7340
	12 June	1153 b	7904	4529 b	
	23 May	8053 a*	10038 a*	9045 a**	
Sunshine F_1	2 June	9737 a	11611 a	10674 a	7726
	12 June	1508 b	5408 b	3458 b	
Mean	23 May	8229	10600	9415 A**	
(Sowing dates)	2 June	9175	9877	9526 A	
	12 June	1818	5213	3516 B	

**Significant at $P < 0.01$, *Significant at $P < 0.05$, NS: Non significant at $P < 0.05$.

CONCLUSION

Consequently, the results of this study suggest that sweet corn had increased the growth characteristics such as yield with early sowings in high altitude conditions. On the other hand, parameters such as plant height, cob weight, cob size, husked and de-husked cob yield examined in the study decreased due to delay in the sowing date. The

highest total husked (17260 kg ha^{-1}) and de-husked (11818 kg ha^{-1}) cob yield were obtained from cv. Martha F_1 in the first sowing (23 May). In addition, when the sowing dates compared to each other, the higher yields were obtained from the first sowing date not only in cv. Martha F_1 but also in all other cultivars. Depending on the delay in the sowing date, the reduction in the weight of the sweet corn cobs reduced also the yield of sweet corn cultivars. In high altitude production areas such as Erzurum, sowing should be done as early as possible for high yield and quality in sweet corn. According to the results of the research, sweet corn can be produced successfully with sowing on 23 May in Erzurum. Also, all of the cultivars used in this research, especially cv. Martha F_1 can be recommended to the sweet corn producer.

ACKNOWLEDGEMENT

This research was supported by funds of Department of Scientific Research Project Management of Atatürk University (BAP) with the project number BAP-2011/191. We would also like to thank the Atatürk University that supported the Project.

Statement of Conflict of Interest

Authors have declared no conflict of interest.

Authors' Contributions

The contributions of authors are equal.

REFERENCES

Abdel-Rahman, A.M., Magboul, E.L., Nour, A.E. 2001. Effects of sowing date and cultivar on yield and yield components of maize in Northern Sudan. 7th Eastern and Southern Africa Regional Maize Conference, Nairobi, Kenya, 11-15 Feb, pp. 295-298.

Anapalli, S.S., Ma, L., Nielsen, D.C., Vigil, M.F., Ahuja, L.R. 2005. Simulating planting date effects on corn production using RZWQM and CERES-Maize models. Agron. J., 17 (97): 58-71.

Dekhane, S.S., Mangave, B.D., Patel, D.J. 2017. Effect of sowing dates on plant growth and yield of hybrid sweet corn. Int. J. Curr. Res., 9 (12): 62132-62133.

Dekhane, S.S., Dumbre, R.B. 2017. Influence of different sowing dates on plant growth and yield of hybrid sweet corns. Adv. Res. J. Crop Improv., 8(2): 191-194.

Eşiyok, D., Bozokalfa, M.K. 2005. Ekim ve dikim zamanlarının tatlı mısırda *(Zea mays* L. *var. saccharata)* verim ve koçanın bazı agronomik karakterleri üzerine etkisi. Ege Üniv. Ziraat Fak. Derg., 42 (1): 35-46.

FAO. 2020. The Food and Agriculture Organization. Food and Agriculture Data. http://www.fao.org/faostat/en/#home (Erişim Tarihi: 15 Şubat 2020).

Fekonja, M., Bavec, F., Grobelnik-Mlakar, S., Turinek, M., Jakop, M., Bavec, M. 2011. Growth Performance of Sweet Maize under Non-Typical Maize Growing Conditions. Biol. Agric. Hortic., 27 (2): 147-164.

Genc L., Inalpulat M., Kizil U., Mirik M., Smith S. E. Mendes M., 2013. Determination of water stress with spectral reflectance on sweet corn (*Zea mays* L.) using classification tree (CT) analysis. Zemdirbyste-Agriculture, 100 (1): 81-90.

Keerthi, P., Prabhakara Reddy, G., Sunitha, N. 2017. Effect of Sowing date on Growth and Yield of Sweet Corn Cultivars. Int. J. Curr. Microbiol. App. Sci., 6 (4): 777-782.

Kharazmshahi, H.A., Zahedi, H., Alipour, A. 2015. Effects of Sowing Date on Yield and Yield Components in Sweet Maize (*Zea mays* L.) Hybrids. Biological Forum – An International Journal, 7 (2): 835-840.

Khan, Z.H., Khalil, S.K., Nigar, S., Khalil, I., Haq, I., Ahmad, I., Ali, A., Khan, M.Y. 2009. Phenology and yield of sweet corn landraces influenced by planting dates. Sarhad J. Agric., 25 (2): 153-157.

Maryam, A.B., Saied, K.K., Habib, S.S., Mandana, D., Khodadad, M., Golbashy, M. 2011. A study on effects of planting dates on growth and yield of 18 corn hybrids (*Zea mays* L.). Am. J. Exp. Agric., 1 (3): 110-120.

Nielson, R.L., Thomison, P.R., Brown, G.A., Halter, A.L., Wells, J., Wuethrich, K.L. 2002. Delayed planting date effects on flowering and grain maturation of corn. Agron. J., 94:549-558.

Rah Khosravani, A.T., Mansourifar, C., Modarres Sanavy, S.A.M., Asilan, K.S., Keshavarz, H. 2017. Effects of Sowing Date on Physiological Characteristics, Yield and Yield Components for Different Maize (*Zea mays* L.) Hybrids. Not. Sci. Biol., 9 (1):143-147.

Rosa, R. 2014. Response of sweet corn cultivated in eastern poland to different sowing dates and covering with non-woven PP. Part II. Ear quality traits. Acta Sci. Pol. Agricultura, 13(4): 113-126.

Rubatzky, V.E., Yamaguchi, M. 1997. World Vegetables. Chapman and Hall, New York, 831 p.

Sarvari, M., Molnar, Z., Hallof, N. 2007. Influence of different sowing date and nutrient supply on the productivity of maize hybrids. Analele University din Oradea, Department of Plant

Production and Applied Ecology, 4 (12): 134-141.

Shaheenuzzamn, M., Saha, R.R., Ahmed, B. Rahman, J., Salim, M. 2015. Green cob and fodder yield of sweet corn as influenced by sowing date in the hilly region. Bangladesh J. Agr. Res., 40 (1): 61-69.

Swiader, J.M., George. W., McCollum, J.P. 1992. Producing Vegetable Crops. Interstate Printers and Publishers, Danville, Illinois, 626 p.

Turgut, İ., Balcı, A. 2002. Bursa koşullarında değişik ekim zamanlarının şeker mısırı *(Zea mays saccharata* Sturt.*)* çeşitlerinin taze koçan verimi ile verim öğeleri üzerine etkileri. Uludağ Üniv. Ziraat Fak. Derg., 16 (2):79-91.

Tuncay, Ö., Bozokalfa, M.K., Eşiyok, D. 2005. Ana ürün ve ikinci ürün olarak yetiştirilen bazı tatlı mısır çeşitlerinde koçanın agronomik ve teknolojik özelliklerinin belirlenmesi. Ege Üniv. Ziraat Fak. Derg., 42 (1): 47-58.

Welbaum, G.E. 2015. Family Poaceae. In: Hulbert S, Hammod C (eds.) Vegetable production and practices, 1st edn. CABI International, Boston, pp. 248-266.