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Determination of Hybrid Cultivars and Seed Sowing Time of Sweet Corn (*Zea Mays* L. Var. *Saccharata*) at High Altitudes

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ABSTRACT: Production and consumption of sweet corn in the world have been increasing. In this context, the aims of our study were to provide an alternative product in high altitude where sweet corn is not common and to determine the yield and quality criteria of different sweet corn cultivars and different seed sowing time in this region, Van (Turkey) having 1720 m altitude. In the study, four hybrid sweet corn (Challenger, Overland, Jubilee and 8529) and one control hybrid maize (3167) were evaluated at four different sowing times (May 27th, June 10th, June 24th and July 8th) in 2014 and 2015. At the end of the study, revealed significant difference of sowing date and cultivars on all yield components. It was determined that the most suitable seed sowing time for sweet corn was between June 24th and July 8th and Challenger was the most suitable cultivar at high altitude.

Keywords: Cultivar, Sowing time, Sweet corn, High altitude, Van.

INTRODUCTION

Corn is one of the abundantly cultivated crops in the world. It is known that corn production is only second to wheat worldwide (FAO, 2011). There are 7 types of corn; waxy, pod, flint, dent, flour, popcorn and sweet corn. The most cultivated forms of corn are dent, popcorn and flint corn (Elci *et al.*, 1994). Although the origins of sweet corn are not completely known, it was estimated that sweet corn was originated from a corn variety known as "Chullpi" or "Chuspillo" (Erdal and Pamukcu, 2005). Furthermore, it is known that a variety called "Papoon" was used in North America environs 200 BC as animal feed (Ugurand Maden, 2015).

Worldwide cultivation of sweet corn has been increasing continuously and significantly. Although sweet corn was introduced in Turkey in early 1930's, its cultivation and consumption have not been extensive until recently. There is no statistical information available on sweet corn cultivation and consumption since sweet corn plant is not well known and its cultivation is limited in Turkey. Towards the end of the 20th Century, sweet corn production increased in coastal areas such as Aegean, Marmara and Mediterranean regions. It could be argued that the reason behind this increase is the increasing demand for sweet corn in the industry lately.

Sweet corn is among the most popular vegetables in the USA and Canada. The USA is the first among sweet corn producers in the world and most of the production is utilized in frozen and canned food industries (Ugurand Maden, 2015). Per capita sweet corn consumption is 6.9 kg in the US and out of this total, 3.4 kg is consumed fresh and 3.5 kg is consumed as frozen or canned form (FAO, 2011).

Sweet corn cobs could be directly consumed with the most preferred method of boiling in water and lately even by presenting kernels separated from the cob in cups and by frying them or could be utilized in the food industry by freezing or canning separated cobs. Thus, its consumption is no longer limited to summer months and it could be consumed all year long. In addition to fresh sweet corn for canning and frozen food industries, green plants left in the field, corn stalks and foliage are valuable raw material for animal feed. These are chopped to feed the animals as well as utilized for silage manufacturing. This production method is widely used in Eastern and Southeastern Anatolian regions in Turkey. It is known that corn is used as a very valuable animal feed in these regions more than human consumption.

The province of Van is situated at 37° 55' and 39° 24' North longitudes and at 42° 05' and 44° 22' East latitudes and Van has a continental climate. Van has 1720 m altitude (Ertek *et al.*, 2004). In this high altitude, sweet corn production is not known. The present study conducted under 1720 m altitude aimed to determine the optimum sowing-time and suitable varieties of sweet corn, which is an alternative produce for Van region, by foreseeing the increasing production and consumption potential of the variety. In the study, we conducted; several characteristics that affect the yield were carefully analyzed. This study is extremely significant in understanding the sweet corn potential of high altitude.

The objective of the current study conducted in Van region is to find which variety would be appropriate for the region and in which sowing-time.

MATERIALS AND METHODS

The study was conducted in a farming land at a 12 km distance from Van Yüzüncü Yıl University (38° 40'N, 43° 16'E) during 2014 and 2015. Climatic data for the land was obtained from Yüzüncü Yıl University meteorological station and given in Table 2. Soil characteristics of the land were analyzed in the laboratory and presented in Table 1.

Table 1: Some physical and chemical characteristics of the research are alands.

Analyze Name	Unit	Method	Result	Explanation
Structure	(%)	Saturation	37.18	Loamy
pH		Saturation	7.89	Mild Alkaline
Total Salt	(%)	Saturation	0.01	Saltless
Lime	(%)	Kalsimetrik	15.46	ExcessLime
OrganicSubstances	(%)	Walkley-black	0.97	VeryLittle
Phosphorus	(kg ha^{-1})	Olsen	127.7	Very High
Potassium	(kg ha^{-1})	A.Asetat-A.A.S.	1982.9	Enough

Table 2: In Van, recorded in 2014 and 2015 years, Relative Humidity (%), Average Temperature (°C), Precipitation (mm) and the average of them for long years (LG).

	The Relative Humidity(%)			Average Temperature (°C)			Precipitation(mm)		
Months	**2014**	**2015**	**LY**	**2014**	**2015**	**LY**	**2014**	**2015**	**LY**
May	50.4	54.0	52.1	14.4	19.7	14.6	21.1	69.3	45.2
June	40.0	38.4	39.2	14.8	25.3	19.9	23.4	34.7	14.1
July	35.8	30.7	33.2	23.2	27.3	23.8	11.1	15.3	5.7
August	31.7	35.2	31.7	24.2	28.3	24.2	5.1	38.9	22.0
September	39.3	37.8	39.3	13.3	19.2	18.3	25.8	28.1	12.9

Challenger, Overland, Jubilee and 8529 cultivars were utilized as sweet corn material in the study and 3167 was used as control maize cultivar that is only known in the region. Four different sowing-times were used on May 27th, June 10th, June 24th and July 8th.

Research in the land has been carried out in three replications as split plot design with random blocks. Interrow and intrarow spaces were determined as 65 cm × 15 cm. Each plot has 15 plants.

Study field was plowed in the spring before sowing in 15-20 cm depth and 0.5 tons of poultry manure was introduced per decare both 2014 and 2015. Herbicide was not used. The diseases or insect hasn't been detected.

Sowing was conducted manually and at 5-6 cm depth and two seeds per pit. Against the risk of the lack of sufficient moisture in the soil for germination, sprinkler irrigation was conducted following the sowing. When the plants reached 20 cm, they were thinned and furrow irrigation was made. Until the plants reached 20 cm sprinkler irrigation and then furrow irrigation were conducted. Irrigation was implemented in specific intervals until the harvest. Irrigation was conducted every 7-8 days bearing in mind daily evaporation and evapotranspiration values. Weed control was conducted by hoeing after sowing. Harvest was implemented based on the browning of cob tassels and sap formation and it was conducted manually.

Measurements and observations (plant height at harvest time (cm), the first cob height at harvest time (cm), coblength (cm), TSS (Brix°), unhusked cob weight (g), thousand kernel weight (g), total fresh husked cob yield(kg ha^{-1}), number of cobs per plant) were conducted based on the methods identified by Agricultural Values Measurement Tests Technical Manual (Anonymous, 2009). In the study, 10 random cobs were collected from each lot and determined measurements and analyses were conducted with these specimens.

Analysis of variance was used for statistical evaluation and Duncan test was used to determine different groups. SPSS (Version 21) statistical software was used for statistical analysis.

RESULTS AND DISCUSSION

A. Plant height at harvest time (cm)

Table 3 reflects that plant height did not differ statistically based on sowing-time and there was a statistical difference between the cultivars. The mean plant height ranged between 190.9 cm (Overland) and 171.3 cm (8529) among all cultivars.

Table 3: Plant Height at Harvest Time (cm).

Years	Sowing times	Challenger	Overland	8529	Jubilee	3167	Mean
	27 May	184.0 ± 5.29 b-d	195.7 ± 2.52 a	167.4 ± 4.62 e	181.0 ± 6.56 cd	183.7 ± 4.51 b-d	**182.36 ± 1.16 n.s**
	10 June	179.0 ± 4.58 d	191.0 ± 3.61 ab	171.0 ± 3.00 e	187.4 ± 2.52 b-d	179.7 ± 5.51 cd	**181.62 ± 1.16 n.s**
2014	**24 June**	182.7 ± 4.73 b-d	186.7 ± 2.08 b-d	163.4 ± 1.53 e	188.0 ± 3.61 a-c	184.0 ± 4.58 b-d	**180.96 ± 1.16 n.s**
	8 July	185.7 ± 4.51 b-d	181.0 ± 3.06 cd	165.4 ± 8.08 e	187.0 ± 2.00 b-d	190.7 ± 6.66 ab	**181.96 ± 1.16 n.s**
	Mean	**182.85 ± 1.30 B**	**188.60 ± 1.30 A**	**166.80 ± 1.30 C**	**185.85 ± 1.30 AB**	**184.52 ± 1.30 B**	
	27 May	175.7 ± 4.04 e-g	195.7 ± 7.57 a-c	179.0 ± 9.00 c-g	191.4 ± 6.51 a-e	177.0 ± 12.29 d-g	**183.76 ± 2.35 n.s**
	10 June	180.7 ± 4.04 c-g	187.4 ± 1.53 a-f	181.7 ± 5.51 c-g	182.4 ± 3.21 c-g	187.7 ± 18.58 a-f	**184.00 ± 2.35 n.s**
2015	**24 June**	177.7 ± 7.09 d-g	200.7 ± 3.79 ab	174.7 ± 2.52 e-g	159.7 ± 23.16 fg	202.4 ± 1.15 a	**183.04 ± 2.35 n.s**
	8 July	182.7 ± 6.43 c-g	189.0 ± 1.00 a-e	168.0 ± 10.15 g	183.7 ± 5.03 b-g	190.4 ± 11.27 a-d	**182.76 ± 2.35 n.s**
	Mean	**179.20 ± 2.63 B**	**193.20 ± 2.63 A**	**175.85 ± 2.63 B**	**179.30 ± 2.63 B**	**189.37 ± 2.63 A**	
	27 May	179.85 ± 4.48 d-f	195.70 ± 5.00 a	173.20 ± 6.60 f-h	186.20 ± 5.35 b-d	180.35 ± 1.65 b-e	**183.06 ± 1.17 n.s**
	10 June	179.85 ± 4.31 d-f	189.20 ± 1.15 a-c	176.35 ± 1.53 e-g	184.90 ± 2.84 b-e	183.70 ± 6.37 c-f	**181.82 ± 1.17 n.s**
Mean	**24 June**	180.20 ± 1.26 d-f	193.70 ± 3.77 ab	169.05 ± 1.73 gh	173.85 ± 5.65 b-d	193.20 ± 6.54 b-e	**182.00 ± 1.17 n.s**
	8 July	184.20 ± 3.75 b-e	185.00 ± 1.89 b-d	166.70 ± 9.12 h	185.35 ± 3.21 b-d	190.55 ± 5.11 b-d	**182.36 ± 1.17 n.s**
	Mean	**181.02 ± 1.31 C**	**190.90 ± 1.31 A**	**171.32 ± 1.31 D**	**182.57 ± 1.31 B**	**186.94 ± 1.31 BC**	

The differences between the averages indicated by different letters are significant (p≤0.05).
n.s : nosignificant

The finding of the present study is consistent with the findings by Lushsinger and Camillo (2008), who reported that plant height differed among cultivars. The findings of this study on plant height were higher than the findings of Idikut *et al*. (2005) in Kahramanmaras region that were between 117.3 cm and 108.9 cm; Turgut and Balci (2002) in Bursa that were between 131.6 cm and 112.0 cm; Bozokalfa *et al.* (2004) that were between 106.5 cm and 127.1 cm and were similar to the findings by Ugur and Maden (2015) in Ordu that were between 188.0 cm (2201) and 220.0 cm (Merit); Atakul (2011) in Diyarbakır region that were between 170.2 cm (Vega) and 204.0 cm (Sakarya); Oktem and Oktem (2006) in Harran Plains that were between 168.0 cm (Secerac) and 206.0 cm (GH-2547). There was a significant variation between our findings on cv. Jubilee (182.5 cm) and the findings by Idikut *et al*. (2005) on the same cultivar (108.9 cm). Also, while Ugur and Maden (2015) found the plant height value for cv. Challenger as 169.0 cm in Ordu, the same figure was 181.0 cm in the current study. It seems like the differences were due to the ecological and agronomic practice differences among the regions.

B. First cob height at harvest time (cm)

It was determined that the data on the height of the lowest first cob differed based on cultivars and sowing-times and the data is presented in Table 4.

It was observed that mean values among sweet corn cultivars differed as for the highest value of 74.8 cm (Overland) and the lowest value of 41.0 cm (Jubilee), while mean sowing-time values differed from 62.0 cm (June 24) to 55.7 cm (May 27). It was reported that as the sowing time was delayed, increases in the temperature resulted in an increase in the first cob height (Atakul, 2011). Current findings are consistent with the results by Anil and Sezer (2003) who reported that first cob height differed among the cultivars and Turgut and Balci (2002) who reported that first cob height increased in late sowing.

Table 4: The First Cob Height atHarvest Time (cm).

Years	Sowingtimes	Challenger	Overland	8529	Jubilee	3167	Mean
	27 May	60.7 ± 3.06 c	71.0 ± 2.00 b	55.4 ± 4.04 c-f	38.4 ± 2.08 ij	47.7 ± 6.43 e-i	**54.64 ± 1.37 B**
	10 June	70.0 ± 4.58 b	81.4 ± 4.16 a	58.0 ± 7.21 cd	42.4 ± 1.53 h-j	46.4 ± 2.52 f-i	**59.64 ± 1.37 A**
2014	**24 June**	74.4 ± 6.43 ab	81.0 ± 4.00 a	70.0 ± 1.00 b	36.4 ± 1.15 j	52.4 ± 1.15 c-g	**62.84 ± 1.37 A**
	8 July	56.7 ± 3.51 c-e	70.7 ± 13.20 b	74.4 ± 4.73 ab	44.0 ± 7.81 g-j	49.0 ± 7.55 d-h	**58.96 ± 1.37 A**
	Mean	**65.45 ± 1.53 B**	**76.02 ± 1.53 A**	**64.45 ± 1.53 B**	**40.30 ± 1.53 D**	**48.87 ± 1.53 C**	
	27 May	54.7 ± 4.16 e-g	77.0 ± 7.21 a	59.4 ± 6.11 c-f	41.4 ± 7.57 hi	51.0 ± 9.00 f-h	**56.70 ± 1.57 B**
	10 June	55.7 ± 8.33 d-f	74.0 ± 6.25 ab	59.0 ± 6.25 c-f	44.4 ± 3.51 g-i	52.7 ± 3.51 e-g	**57.16 ± 1.57 A**
2015	**24 June**	63.4 ± 6.56 c-f	77.0 ± 8.72 a	68.0 ± 6.00 a-c	37.4 ± 2.52 i	60.0 ± 2.00 c-f	**61.16 ± 1.57 A**
	8 July	63.0 ± 4.36 b-e	66.7 ± 7.23 a-d	73.0 ± 2.65 ab	43.7 ± 3.21 g-i	55.7 ± 8.14 d-f	**60.42 ± 1.57 A**
	Mean	**59.20 ± 1.75 C**	**73.67 ± 1.75 A**	**64.85 ± 1.75 B**	**41.72 ± 1.75 D**	**54.85 ± 1.75 C**	
	27 May	57.70 ± 3.21 e-g	74.0 ± 4.00 ab	57.40 ± 4.37 e-g	39.90 ± 4.65 i	49.35 ± 7.29 gh	**55.7 ± 1.34 B**
	10 June	62.85 ± 6.21 c-e	77.70 ± 6.61 ab	58.50 ± 6.50 d-g	43.40 ± 2.52 hi	49.55 ± 2.65 gh	**58.4 ± 1.34 AB**
Mean	**24 June**	68.90 ± 5.97 b-d	79.0 ± 6.08 ab	69.00 ± 3.01 bc	36.90 ± 1.76 i	56.20 ± 0.58 e-g	**62.0 ± 1.34 A**
	8 July	59.85 ± 1.15 d-f	68.70 ± 10.02 bc	73.70 ± 3.51 ab	43.85 ± 5.13 hi	52.35 ± 7.29 f-h	**59.69 ± 1.34 A**
	Mean	**62.32 ± 1.50 B**	**74.84 ± 1.50 A**	**64.65 ± 1.50 B**	**41.01 ± 1.50 D**	**51.86 ± 1.50 C**	

The differences between the averages indicated by different letters are significant (p≤0.05).

The findings of this study on first cob height were higher than the findings of Idikut *et al.* (2005) in Kahramanmaras region that were between 24.7 cm (Jubilee) and 40.5 cm (Merit); Bozokalfa *et al.* (2004) in Aegean Region that were between 18.5 cm and 33.7 cm and were similar to the findings by Atakul (2011) in Diyarbakir region that were between 47.0 cm and 72.9 cm; Oktem and Oktem (2006) in Harran Plains that were between 56.3 cm and 70.1 cm; Turgut and Balci (2002) in Bursa that were between 58.8 cm and 42.6 cm.

C. Number of cobs per plant

Table 5 demonstrates that sowing-times and cultivars differed based on number of cobs per plant. 8 July sowing yielded the highest number of cobs per plant. Late sowing exhibited an increase in number of cobs per plant, which contributed greatly to the plant yield. Thus, it is possible to argue that the increase in number of cobs per plant with late sowing was parallel to the yield. The difference in number of cobs per plant among the cultivars was statistically significant. The cv. 3167 which is normal maize cultivar yielded the highest number of cobs per plant (1.76 cob/plant). Assessment of number of cobs per plant for all examined sweet corn cultivars demonstrated that the highest number of cobs per plant was observed with cv. Challenger which had the highest yield (1.23 cob/plant) and the lowest number of cobs per plant was observed with cv. Jubilee (0.98 cob/plant).

Table 5: Numberof Cobs Per Plant.

Years	Sowingtimes	Challenger	Overland	8529	Jubilee	3167	Mean
	27 May	1.10 ± 0.00 d-f	0.93 ± 0.05 fg	1.16 ± 0.05 c-e	0.86 ± 0.05 g	1.70 ± 0.10 b	**1.15 ± 0.02 C**
	10 June	1.23 ± 0.05 cd	1.03 ± 0.17 e-g	1.26 ± 0.15 cd	0.93 ± 0.05 fg	1.80 ± 0.00 ab	**1.25 ± 0.02 B**
2014	**24 June**	1.30 ± 0.17 c	1.13 ± 0.05 c-e	1.16 ± 0.05 c-e	1.03 ± 0.20 e-g	1.66 ± 0.15 b	**1.25 ± 0.02 B**
	8 July	1.26 ± 0.05 cd	1.16 ± 0.10 c-e	1.26 ± 0.05 cd	1.10 ± 0.10 d-f	1.93 ± 0.15 a	**1.34 ± 0.02 A**
	Mean	**1.22 ± 0.02 B**	**1.06 ± 0.02 C**	**1.21 ± 0.02 B**	**0.98 ± 0.02 D**	**1.77 ± 0.02 A**	
	27 May	1.10 ± 0.00 e-h	1.00 ± 0.17 g-i	1.23 ± 0.15 c-e	0.86 ± 0.05 i	1.70 ± 0.10 b	**1.18 ± 0.02 C**
	10 June	1.16 ± 0.05 d-g	1.10 ± 0.10 e-h	1.20 ± 0.10 d-f	0.93 ± 0.05 hi	1.80 ± 0.00 ab	**1.24 ± 0.02 BC**
2015	**24 June**	1.30 ± 0.10 cd	1.13 ± 0.05 d-g	1.23 ± 0.05 c-e	1.03 ± 0.20 f-i	1.64 ± 0.15 b	**1.27 ± 0.02 B**
	8 July	1.40 ± 0.10 c	1.23 ± 0.05 c-e	1.26 ± 0.05 c-e	1.10 ± 0.05 d-g	1.91 ± 0.05 a	**1.38 ± 0.02 A**
	Mean	**1.24 ± 0.02 B**	**1.11 ± 0.02 C**	**1.23 ± 0.02 B**	**0.98 ± 0.02 D**	**1.76 ± 0.02 A**	
	27 May	1.10 ± 0.00 e-h	0.96 ± 0.11 h-j	1.19 ± 0.00 c-f	0.86 ± 0.05 j	1.70 ± 0.00 b	**1.16 ± 0.22 C**
	10 June	1.19 ± 0.00 c-f	1.06 ±0.05 f-i	1.23 ± 0.10 c-e	0.93 ± 0.05 ij	1.80 ± 0.00 ab	**1.24 ± 0.22 B**
Mean	**24 June**	1.30 ± 0.10 c	1.13 ± 0.05 d-g	1.19 ± 0.00 c-f	1.03 ± 0.20 g-i	1.65 ± 0.05 b	**1.26 ± 0.22 B**
	8 July	1.33 ± 0.05 c	1.19 ± 0.00 c-f	1.26 ± 0.05 cd	1.10 ± 0.05 d-g	1.92 ± 0.05 a	**1.36 ± 0.22 A**
	Mean	**1.23 ± 0.24 B**	**1.08 ± 0.24 C**	**1.22 ± 0.24 B**	**0.98 ± 0.24 D**	**1.76 ± 0.24 A**	

The differences between the averages indicated by different letters are significant (p≤0.05).

Findings of the present study were similar to the results reported by Waligora (1997), who stated that late sowing increased number of cobs per plant and Tuncay *et al.* (2005), who reported that cob number of cobs plant was reduced with early sowing. It was found that sowing-times and the cultivars used in the study affected number of cobs per plant as noted by Cesurer and Ulger (1997). The findings of this study were lower than the findings by Turgut and Balci (2002) that were between 1.6 cob/plant and 1.8 cob/plant; Idikut *et al.* (2005) that were between 1.3 cob/plant (cv. Merit) and 1.6 cob/plant (cv. Jubilee); Bozokalfa *et al.* (2004) that were between 1.2 cob/plant and 1.5 cob/plant and were higher than the findings by Atakul (2011) that were between 0.93 cob/plant (cv. Merit) and 1.03 cob/plant (cv. Jubilee). It was predicted that these differences were due to the differences in soil and climate characteristics of the studied fields and applied cultural practices. Number of cobs per plant findings for cv. Jubilee was lower than the results of the studies by Idikut *et al.* (2005), where the value was found as 1.3 cob/plant and Albayrak (2013), where the value was found as 1.5 cob/plant and parallel to the study by Atakul (2011), where the related figure was 1.03 cob/plant.

D. Cob length (cm)

There was a difference between the cob lengths for sweet corn varieties used in the study. Table 6 demonstrates that the mean cob lengths obtained in the present study varied from 17.0 cm (Jubilee) to 22.2 cm (3167). In addition to the fact that sowing-times were found to be statistically significant (p≤0.05).It was found that late sowing affected an increase in cob lengths and the yield.

In certain studies conducted on sweet corn, it was reported that cob length values varied among different cultivars (Harper, 1994). In a study conducted by Waligora (1997) in Poland, it was determined that late sowing resulted in lower cob lengths, but the cob length was affected by late sowing less when compared to other parameters. Contrary to Waligora's determination, late sowing positively affected cob length in the present study. Albayrak (2013) reported that climatic conditions and cultural applications affected cob length.

Table 6: Cob Length (cm).

Years	Sowing times	Challenger	Over land	8529	Jubilee	3167	Mean
	27 May	19.6 ± 1.22 e-g	19.3 ± 0.55 fg	20.4 ± 1.15 c-g	16.7 ± 0.53 i	22.3 ± 1.62 ab	**19.66 ± 0.20 BC**
	10 June	21.5 ± 0.90 b-d	19.7 ± 0.67 d-g	20.9 ± 0.67 b-f	17.2 ± 0.25 i	22.2 ± 1.11 ab	**20.30 ± 0.20 AB**
2014	**24 June**	20.5 ± 0.95 c-g	18.9 ± 1.15 gh	20.0 ± 0.50 c-g	16.2 ± 0.25 i	21.5 ± 0.71 b-d	**19.42 ± 0.20 C**
	8 July	21.2 ± 1.49 b-e	20.3 ± 0.38 c-g	21.5 ± 0.96 bc	17.4 ± 0.90 hi	23.6 ± 0.91 a	**20.80 ± 0.20 A**
	Mean	**20.70 ± 0.22 B**	**19.55 ± 0.22 C**	**20.70 ± 0.22 B**	**16.87 ± 0.22 D**	**22.40 ± 0.22 A**	
	27 May	19.4 ± 0.30 b-d	19.7 ± 1.18 bc	20.7 ± 1.70 ab	17.5 ± 1.20 c-e	22.3 ± 0.62 a	**19.92 ± 0.32 B**
	10 June	21.1 ± 0.64 ab	20.0 ± 0.43 ab	20.7 ± 0.97 ab	16.6 ± 0.65 e	22.2 ± 1.10 a	**20.12 ± 0.32AB**
2015	**24 June**	20.0 ± 0.41 ab	20.7 ± 0.50 ab	21.4 ± 3.13 ab	17.3 ± 1.36 de	21.7 ± 1.34 ab	**20.22 ± 0.32 A**
	8 July	21.1 ± 2.10 ab	19.5 ± 0.90 b-d	20.8 ± 0.50 ab	17.6 ± 1.21 c-e	22.2 ± 1.15 a	**20.24 ± 0.32 A**
	Mean	**20.40 ± 0.36 B**	**19.97 ± 0.36 B**	**20.90 ± 0.36 B**	**17.25 ± 0.36 C**	**22.10 ± 0.36 A**	
	27 May	19.50 ± 0.72 ab	19.50 ± 0.65 ab	20.55 ± 1.13 ab	17.10 ± 0.96 c	22.30 ± 1.10 a	**19.79 ± 0.61 B**
	10 June	21.30 ± 0.57 ab	19.85 ± 0.55 ab	20.80 ± 0.76 ab	16.90 ± 0.26 b	22.20 ± 1.10 a	**20.21 ± 0.61 AB**
Mean	**24 June**	20.25 ± 0.66 ab	19.80 ± 0.34 ab	20.70 ± 1.56 ab	16.75 ± 0.62 b	21.60 ± 0.96 a	**19.82 ± 0.61 AB**
	8 July	21.15 ± 1.73 ab	19.90 ± 0.45 ab	21.15 ± 0.66 ab	17.50 ± 3.52 ab	22.90 ± 0.83 a	**20.52 ± 0.61 A**
	Mean	**20.55 ± 6.85 AB**	**19.76 ± 6.85 B**	**20.80 ± 6.85 AB**	**17.06 ± 6.85 C**	**22.25 ± 6.85 A**	

The differences between the averages indicated by different letters are significant (p≤0.05).

The findings of this study on cob length were higher than the findings by Esiyok and Bozokalfa (2005) that were between 13.0 cm and 19.8 cm and similar to the findings by Albayrak (2013) that were between 16.9 cm and 22.8 cm; Bozokalfa *et al*. (2004) that were between 20.4 cm and 18.7 cm; Atakul (2011) that were between 17.5 cm and 20.5 cm; Turgut and Balci (2002) that were between 19.7 cm and 18.8 cm; Oktem and Oktem (2006) that were between 17.2 cm (Secerac) and 23.3 cm (Lincoln).

E. TSS (°Brix)

Table 7 demonstratesthatTSS data were the lowest for cv. 3167 which is a control maize, with a value of 15.1 °Brix and TSS value for all sweet corn cultivars varied from 20.3 °Brix (cv. 8529) to 21.7 °Brix (cv. Challenger) (p≤0.05). It was found that sowing-time did not significantly affect the TSS value; however sowing time x cultivars interaction demonstrated that the highest TSS value was found in cv. Challenger in June 24th sowing with 23.5 °Brix, and the lowest °Brix value was found in cv. 3167 in May 27th sowing with 14.4 °Brix value.

The findings of this study for TSS value were higher than the findings by Esiyok and Bozokalfa (2005) that were between 12.7 °Brix and 18.6 °Brix and lower than the findings by Albayrak (2013) that were between 22.3 °Brix (Jubilee) and 27.1 °Brix (SweetCorn) and Atakul (2011) that was at an average of 26.4 °Brix and similar to the findings reported by Ugurand Maden (2015) in Ordu that were between 18.6 °Brix and 20.6 °Brix and Esiyok *et al*. (2004) that were between 21.2 °Brix and 15.1 °Brix. The observed differences in TSS values could be due to differences in material used in these studies. The °Brix values obtained in the current study for cv. Jubilee were lower than the values obtained by Atakul (2011) (24.7 °Brix) and Albayrak (2013) (22.3 °Brix).

Table 7. TSS (Brix°).

Years	Sowing times	Challenger	Overland	8529	Jubilee	3167	Mean
	27 May	20.5 ± 0.71 bc	20.4 ± 1.23 bc	19.5 ± 0.80 bc	20.2 ± 1.47 bc	14.0 ± 0.81 d	**18.92 ± 0.37 n.s**
	10 June	21.7 ± 1.91 bc	22.3 ± 1.54 ab	20.0 ± 2.54 bc	19.8 ± 0.25 bc	14.7 ± 2.14 d	**19.70 ± 0.37 n.s**
2014	**24 June**	24.0 ± 2.05 a	20.2 ± 0.95 bc	20.1 ± 1.21 bc	22.1 ± 1.13 ab	15.6 ± 1.68 d	**20.40 ± 0.37 n.s**
	8 July	20.8 ± 1.10 bc	20.0 ± 1.11 bc	18.3 ± 0.61 c	21.0 ± 0.78 bc	15.1 ± 1.99 d	**19.04 ± 0.37 n.s**
	Mean	**21.75 ± 0.41 A**	**20.72 ± 0.41 AB**	**19.47 ± 0.41 B**	**20.77 ± 0.41AB**	**14.85 ± 0.41 C**	
	27 May	20.5 ± 0.86 ab	20.8 ± 1.05 ab	22.4 ± 3.23 ab	19.7 ± 0.67 ab	14.8 ± 0.76 d	**19.64 ± 0.42 n.s**
	10 June	21.5 ± 1.00 ab	20.8 ± 1.95 ab	19.7 ± 0.72 bc	20.0 ± 1.80 bc	16.9 ± 2.55 cd	**19.78 ± 0.42 n.s**
2015	**24 June**	23.0 ± 1.71 a	21.2 ± 1.31 ab	21.7 ± 0.97 ab	21.0 ± 1.87 ab	14.6 ± 1.15 d	**20.30 ± 0.42 n.s**
	8 July	21.8 ± 2.40 ab	19.6 ± 0.57 bc	21.0 ± 0.62 ab	19.9 ± 1.47 a-c	15.6 ± 1.54 d	**19.58 ± 0.42 n.s**
	Mean	**21.70 ± 0.47 A**	**20.60 ± 0.47 AB**	**21.20 ± 0.47 AB**	**20.15 ± 0.47 B**	**15.47 ± 0.47 C**	
	27 May	20.50 ± 0.61 b	20.60 ± 1.06 b	20.95 ± 1.55 ab	19.95 ± 0.55 b	14.40 ± 2.81 c	**19.28 ± 0.35 n.s**
	10 June	21.60 ± 1.53 ab	21.55 ± 0.75 ab	19.85 ± 1.62 b	19.90 ± 0.79 b	15.80 ± 2.45 c	**19.74 ± 0.35 n.s**
Mean	**24 June**	23.50 ± 1.46 a	20.70 ± 0.56 b	20.90 ± 1.57 b	21.55 ± 1.48 ab	15.10 ± 3.10 c	**20.35 ± 0.35 n.s**
	8 July	21.30 ± 1.67 ab	19.80 ± 0.10 b	19.65 ± 0.38 b	20.45 ± 1.04 b	15.35 ± 2.37 c	**19.31 ± 0.35 n.s**
	Mean	**21.72 ± 0.39 A**	**20.66 ± 0.39 AB**	**20.33 ± 0.39 B**	**20.46 ± 0.39 B**	**15.16 ± 0.39 C**	

The differences between the averages indicated by different letters are significant (p≤0.05).

F. Unhusked Cob Weight (g)

Unhusked cob weight values varied from 208.6 g (cv. Jubilee) to 298.6 g (cv. 8529) among sweet corn cultivars and sowing times varied from 273.8 g (27 May) to 290.9 g (8 July) (Table 8) ($p \leq 0.05$). The findings of this study for unhusked cob weight were lower than the findings by Sonmez *et al*. (2013) that were between 338.9 g (Jubilee) and 406.5 g (Sunshine) but higher than the findings by Albayrak (2013) that were between 109.3 g and 164.3 g; by Turgut andBalci (2002) that were between 181.5 g and 194.9 g; by Esiyok and Bozokalfa (2005) that were between 190.0 g and267.0 g; byEsiyok *et al*. (2004) that were between 236.6 g and 201.3 g; byGenctanandUckesen (2001) that were between 163.4 g and 225.8 g. The findings of this study for unhusked cob weight were similar to the findings by OktemandOktem (2006) in Harran Plain region that were between 268.2 g and 302.1 g; by Bozokalfa *et al*. (2004) in Aegean conditions that were 257.6 g and 298.7 g. In a similar study conducted by Sönmez *et al*. (2013), unhusked cob weight was found as 338.2 g for cv. Jubilee and Albayrak (2013), in a similar study, determined the same parameter as 126.0 g for the cv. Jubilee. In the present study, unhusked cob weight value found was lower than the finding by Sonmez *et al*. (2013) but higher than the result obtained by Albayrak (2013).

Table 8: Unhusked CobWeight (g).

Years	Sowingtimes	Challenger	Overland	8529	Jubilee	3167	Mean
	27 May	300.1 ± 6.49 a-c	262.6 ± 11.77 d	296.9 ± 8.68 a-c	196.9 ± 9.56 e	313.9 ± 11.58 a	**274.08 ± 3.09 B**
	10 June	298.7 ± 2.77 a-c	280.6 ± 9.95 cd	302.0 ± 20.90 a-c	195.0 ± 6.65 e	310.8 ± 7.52 ab	**277.42 ± 3.09AB**
2014	**24 June**	279.8 ± 16.74 cd	301.8 ± 12.40 a-c	287.8 ± 19.40 bc	190.2 ± 9.83 e	304.9 ± 12.16 ab	**272.90 ± 3.09 B**
	8 July	301.7 ± 13.07 a-c	302.9 ± 15.27 a-c	303.0 ± 7.70 a-c	197.3 ± 9.38 e	313.2 ± 12.03 a	**283.62 ± 3.09 A**
	Mean	**295.07 ± 3.46 BC**	**286.97 ± 3.46 C**	**297.42 ± 3.46 B**	**194.85 ± 3.46 D**	**310.70 ± 3.46 A**	
	27 May	290.0 ± 6.43 ab	259.1 ± 6.41 bc	304.7 ± 13.47 a	190.0 ± 10.00 d	324.6 ± 10.20 a	**273.68 ± 5.03 B**
	10 June	302.9 ± 13.04 a	287.9 ± 17.72 ab	298.5 ± 28.69 a	201.7 ± 3.35 d	323.4 ± 7.75 a	**282.88 ± 5.03 B**
2015	**24 June**	289.8 ± 31.50 ab	301.6 ± 0.85 a	289.1 ± 33.15 ab	240.6 ± 49.18 c	317.4 ± 15.01 a	**287.70 ± 5.03AB**
	8 July	309.7 ± 8.18 a	290.7 ± 11.86 ab	307.1 ± 7.48 a	257.2 ± 26.89 bc	326.3 ± 6.18 a	**298.20 ± 5.03 A**
	Mean	**298.10 ± 5.63 B**	**284.82 ± 5.63 B**	**299.85 ± 5.63 B**	**222.37 ± 5.63 C**	**322.92 ± 5.63 A**	
	27 May	295.05 ± 6.46 a-c	260.85 ± 7.48 d	300.80 ± 11.10 a-c	193.45 ± 9.58 f	319.25 ± 7.98 a	**273.88 ± 3.29 B**
	10 June	300.80 ± 7.92 a-c	284.25 ± 13.43 c	300.25 ± 24.43 a-c	198.35 ± 4.44 f	317.10 ± 6.12 a	**280.15 ± 3.29 B**
Mean	**24 June**	284.80 ± 23.92 c	301.70 ± 6.62 a-c	288.45 ± 8.06 bc	215.40 ± 25.64ef	311.15 ± 12.21ab	**280.30 ± 3.29 B**
	8 July	305.70 ± 10.60 a-c	296.80 ± 13.19 a-c	305.05 ± 6.68 a-c	227.25 ± 8.91 e	319.75 ± 9.08 a	**290.91 ± 3.29 A**
	Mean	**296.58 ± 3.68 B**	**285.89 ± 3.68 C**	**298.63 ± 3.68 B**	**208.61 ± 3.68 D**	**316.81 ± 3.68 A**	

The differences between the averages indicated by different letters are significant ($p \leq 0.05$).

G. Thousand Kernel Weight (g)

Thousand kernel weight varied between 131.7 g (Jubilee) and 266.3 g (Challenger) among the sweet corn cultivars and the highest thousand kernel weight was obtained with cv. 3167 (322.1 g), which is a normal maize cultivar. The differences among the cultivars were statistically significant ($p \leq 0.05$) and it is shown in Table 9 that the sowing-time did not have any impact on thousand kernel weight.

Table 9: Thousand Kernel Weight (g).

Years	Sowing times	Challenger	Overland	8529	Jubilee	3167	Mean
	27 May	247.4 ± 19.01 ab	150.0 ± 16.37 ef	220.7 ± 10.07 b-d	152.0 ± 12.16 ef	337.7 ± 17.61 a	**221.56 ± 6.31n.s**
	10 June	253.7 ± 27.57 ab	148.4 ± 37.58 ef	255.4 ± 50.01 ab	118.4 ± 14.29 f	308.4 ± 6.03 a	**216.86 ± 6.31n.s**
2014	**24 June**	263.7 ± 18.23 b	212.7 ± 22.85 cd	209.4 ± 11.02 cd	123.0 ± 13.11 f	315.0 ± 22.72 a	**224.76 ± 6.31n.s**
	8 July	255.4 ± 23.03 ab	153.4 ± 53.00 ef	185.4 ± 16.80 de	132.0 ± 22.52 f	317.4 ± 8.62 a	**208.72 ± 6.31n.s**
	Mean	**255.05 ± 7.06 B**	**166.12 ± 7.06 D**	**217.72 ± 7.06 C**	**131.35 ± 7.06 E**	**319.62 ± 7.06 A**	
	27 May	281.7 ± 19.55 b	162.0 ± 14.73 de	210.4 ± 17.61 c	139.7 ± 51.85 e	317.4 ± 26.63 ab	**222.42 ± 6.93n.s**
	10 June	275.0 ± 20.22 b	139.7 ± 31.55 e	213.7 ± 24.13 c	161.0 ± 31.43 de	347.4 ± 42.00 a	**227.36 ± 6.93n.s**
2015	**24 June**	280.7 ± 22.00 b	153.0 ± 38.70 de	211.7 ± 11.84 c	108.4 ± 12.50 e	322.4 ± 5.03 ab	**215.24 ± 6.93n.s**
	8 July	273.4 ± 37.07 b	157.7 ± 37.07 de	195.4 ± 5.50 cd	119.7 ± 10.26 e	311.7 ± 8.62 ab	**211.58 ± 6.93n.s**
	Mean	**277.70 ± 7.75 B**	**153.10 ± 7.75 D**	**207.80 ± 7.75 C**	**132.20 ± 7.75 D**	**324.72 ± 7.75 A**	
	27 May	264.55 ± 11.32 b	156.00 ± 19.22e-g	215.55 ± 13.25 cd	145.85 ± 23.80fg	327.55 ± 22.12 a	**221.99 ± 5.75n.s**
	10 June	264.35 ± 23.38 b	144.05 ± 24.82e-g	234.55 ± 36.95 bc	139.70 ± 22.53 g	327.90 ± 20.68 a	**222.11 ± 5.75n.s**
Mean	**24 June**	272.20 ± 20.03 b	182.85 ± 30.36d-f	210.55 ± 11.06 cd	115.70 ± 7.85 g	318.70 ± 11.68 a	**220.00 ± 5.75n.s**
	8 July	264.40 ± 29.41 b	155.55 ± 44.61e-g	190.40 ± 9.78 de	125.85 ± 8.28 g	314.55 ± 7.47 a	**210.15 ± 5.75n.s**
	Mean	**266.37 ± 6.43 B**	**159.61 ± 6.43 D**	**212.76 ± 6.43 C**	**131.77 ± 6.43 E**	**322.17 ± 6.43 A**	

The differences between the averages indicated by different letters are significant ($p \leq 0.05$).

The findings of this study for thousand kernel weight were lower than the findings by Alan *et al.* (2005) who reported in a similar study the variation in thousand kernel weight between 338.9 g (Jubilee) and 406.5 g (Sunshine) in Küçük Menderes conditions; Kaya and Kusaksız (2012) who reported the variation in thousand kernel weight between 263.0 g (Maverick) and 359.0 g (c-955) in Küçük Menderes conditions; Sirikci (2006) who reported the variation in thousand kernel weight between 367.3 g and 482.0 g in Kahramanmaraş conditions but similar to the findings by Albayrak (2013) who reported in a similar study the variation in thousand kernel weight between 198.3 g (Martha) and 168.2 g (SweetCorn); by Esiyok *et al.* (2005) who reported the variation in thousand kernel weight between 207.0 g and 143.0 g in Aegean Region.

H. Total FreshHuskedCobYield (kg ha^{-1})

When total fresh husked cob yield is analyzed for sweet corn cultivars, it was found that sowing-time and cultivars were statistically significant ($p \leq 0.05$). The highest total fresh husked cob yield was obtained with cv. Challenger (29 179 kg ha^{-1}) and the lowest total fresh husked cob yield was obtained cv. Jubilee (21 318 kg ha^{-1}) for sweet corn cultivars (Table 10). Sowing-time was also found to be statistically significant ($p \leq 0.05$) and it was determined that late sowing resulted in an increase in the yield. This was due to the increase in temperatures as a result of late sowing. The high temperatures and precipitation observed during the 2015 vegetation period caused an increase in total fresh husked cob yield in 2015.

The findings of this study were higher than the findings by Kaya andKusaksız (2012) who reported in a similar study the variation in husked cob yield between 7 150 kg ha^{-1} and 18 070 kg ha^{-1}; Bozokalfa *et al*. (2004) who reported between 12 410 kg ha^{-1} and 16 100 kg ha^{-1}; Atakul (2011) who reported between 8 680 kg ha^{-1}and 19 880 kg ha^{-1}; Albayrak (2013) who reported between 5 820 ha^{-1} and 9 130 ha^{-1}.

It was considered that the differences were due to soil and climate conditions in study fields and among the cultivars used in different studies. The findings of our study were similar to the studies where Sonmez *et al*. (2013) reported it between 19 340 kg ha^{-1}and 23 250 kg ha^{-1}; Esiyok and Bozokalfa (2005) reported between 27 610 kg ha^{-1} and 30 350 kg ha^{-1}; Koca and Erekul (2011) reported as 25 300 kg ha^{-1} in cv. C-955.

Table 10: Total Fresh Husked Cob Yield (kg ha^{-1}).

Years	Sowingtimes	Challenger	Overland	8529	Jubilee	3167	Mean
2014	**27 May**	2711.0 ± 46.86 c	2199.3 ± 79.38 e	2436.6 ± 21.20 d	1903.3 ± 66.64 f	3152.2 ± 140.01 b	**2480.48 ± 26.50 C**
	10 June	2848.5 ± 30.20 c	2370.6 ± 104.47 d	2399.0 ± 219.50 d	1945.5 ± 72.45 f	3077.2 ± 147.70 b	**2528.16 ± 26.50 C**
	24 June	2897.7 ± 49.83 c	2391.2 ± 87.49 d	2769.9 ± 100.58 c	2151.1 ± 165.27 e	3437.4 ± 141.74 a	**2729.46 ± 26.50 B**
	8 July	3133.8 ± 30.62 b	2433.3 ± 30.85 d	2738.7 ± 107.93 c	2509.9 ± 78.50 d	3389.7 ± 57.50 a	**2841.08 ± 26.50**
	Mean	**2897.75 ± 29.63 B**	**2348.60 ± 29.63 D**	**2586.05 ± 29.63 C**	**2127.45 ± 29.63 E**	**3264.12 ± 29.63 A**	
2015	**27 May**	2776.8 ± 102.72 c	2294.1 ± 100.60ef	2514.8 ± 34.48 d	1916.9 ± 74.10 g	3114.2 ± 126.10 b	**2523.36 ± 27.02 C**
	10 June	2890.5 ± 86.51 c	2383.8 ± 104.15 de	2453.8 ± 223.07 de	1947.3 ± 74.57 g	3117.8 ± 99.36 b	**2558.64 ± 27.02 C**
	24 June	2902.1 ± 53.53 c	2447.8 ± 45.95 de	2804.3 ± 88.21 c	2140.1 ± 144.05 f	3482.2 ± 141.56 a	**2755.30 ± 27.02 B**
	8 July	3183.4 ± 20.72 b	2459.7 ± 40.36 de	2740.3 ± 156.23 c	2540.5 ± 36.45 d	3460.1 ± 104.69 a	**2876.80 ± 27.02 A**
	Mean	**2938.20 ± 30.21 B**	**2396.35 ± 30.21 D**	**2628.30 ± 30.21 C**	**2136.20 ± 30.21 E**	**3293.57 ± 30.21 A**	
Mean	**27 May**	2743.9 ± 73.50 c	2246.7 ± 89.63 ef	2475.7 ± 24.16 d	1910.1 ± 70.22 g	3133.2 ± 113.24 b	**2501.92 ± 25.89 C**
	10 June	2869.5 ± 57.49 c	2377.2 ± 102.82 de	2426.4 ± 221.28 d	1946.4 ± 73.51 g	3097.5 ± 122.97 b	**2543.40 ± 25.89 C**
	24 June	2899.9 ± 51.65 c	2419.5 ± 64.29 de	2787.1 ± 92.06 c	2145.6 ± 154.62 f	3459.8 ± 141.54 a	**2742.38 ± 25.89 B**
	8 July	3158.6 ± 14.41 b	2446.5 ± 27.05 d	2739.5 ± 127.77 c	2525.2 ± 57.42 d	3424.9 ± 79.28 a	**2858.94 ± 25.89 A**
	Mean	**2917.97 ± 28.95 B**	**2372.47 ± 28.95 D**	**2607.17 ± 28.95 C**	**2131.82 ± 28.95 E**	**3278.84 ± 28.95 A**	

The differences between the averages indicated by different letters are significant ($p \leq 0.05$).

CONCLUSION

It was determined that increasing soil and ambient temperatures resulted in positive outcomes for the sweet corn that reacts well to warm temperatures and caused increases in cob length, unhusked cob weight, cobs number per plant and these increased resulted in a better yield.

The properties investigated in the current study are the basic parameters that affect the yield and the quality. It was determined that these parameters vary with sowing periods and cultivars used. It was further identified that cv. Challenger performed the best with respect to all investigated parameters. Larger kernel and high kernel weight of cv. Challenger render this cultivar more usable for canning and frozen food industries when compared to other cultivars.

The present study conducted in Van region showed that the earliest cultivar was Overland and the latest one was 8529. It was found that sweet corn cultivars matured earlier than cv. 3167 which is control maize. As a result, it was determined that 1720 m altitude is suitable for sweet corn cultivation and the most suitable cultivars were cv. Challenger and cv. 8529, the most suitable sowing periods were from June 24th to July 8th.

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