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Determination of Sowing Dates of Sweet Corn (*Zea mays* L. *saccharata* Sturt.) under Şanlıurfa Conditions

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Abstract: This study was conducted to determine optimum sowing dates for sweet corn in the Southeastern Anatolia region. The research was carried out at the Agricultural Research Station of Harran University in Şanlıurfa during 2000 and 2001. Sowing dates were April 25, May 10, May 25, June 10, June 25, July 10, July 25 and August 10. Based on the sowing dates, fresh ear yield, duration of tasseling, ear diameter, kernel numbers per ear, single fresh ear weight and husk ratio parameters were statistically significant (**P < 0.01) in both years. The highest fresh ear yields were 177.51 and 172.30 kg ha^{-1} for the 25 July sowing date in 2000 and 2001, respectively. The lowest fresh ear yields were 18.24 and 15.53 kg ha^{-1} for the April 25 sowing date in 2000 and 2001, respectively. Fresh ear yield decreased with early sowing dates (from April 25 to June 25) in both years. The results indicate that optimal sowing dates for sweet corn could be from June 25 to July 25 in Şanlıurfa and similar Southeastern Anatolia regions.

Key Words: sowing date, sweet corn, Harran Plain, Southeastern Anatolia

Şanlıurfa Koşullarında Şeker Mısır (*Zea mays* L. *saccharata* Sturt.) Ekim Zamanının Belirlenmesi

Özet: Bu çalışma şeker mısırın Güneydoğu Anadolu bölgesinde en uygun ekim zamanını belirlemek amacıyla Harran Üniversitesi Ziraat Fakültesi Deneme alanında 2000 ve 2001 yıllarında Şanlıurfa'da yürütülmüştür. Çalışmada; 25 Nisan, 10 Mayıs, 25 Mayıs, 10 Haziran, 25 Haziran, 10 Temmuz, 25 Temmuz, 10 Ağustos ekim zamanları ele alınmıştır. Ekim zamanları arasında her iki deneme yılında da taze koçan verimi, tepe püskülü çiçeklenme süresi, koçan çapı, koçanda tane sayısı, taze tek koçan ağırlığı ve koçan kavuz oranı bakımından istatistiki önemde (**P < 0.01) farklılıklar belirlenmiştir. En yüksek taze koçan verimi 2000 ve 2001 deneme yıllarında (177.51 ve 172.30 kg ha^{-1}) 25 Temmuz; en düşük değerler ise (18.24 ve 15.53 kg ha^{-1}) 25 Nisan ekim zamanında belirlenmiştir. Taze koçan verimi her iki deneme yılında da erken ekim zamanlarında (25 Nisan-25 Haziran) düşük bulunmuştur. Araştırma sonuçları; şeker mısır için en uygun ekim zamanının Şanlıurfa ve Güneydoğu Anadolu bölgesinde benzer iklim koşullarına sahip yerler için 25 Haziran ile 25 Temmuz arası olduğunu göstermiştir.

Anahtar Sözcükler: ekim zamanı, şeker mısır, Harran Ovası, Güneydoğu Anadolu

Introduction

In many parts of the world, corn is the most important food source and one of the most efficient field crops in producing a superior amount of dry matter per unit area. Field corn is produced primarily for animal feed and industrial uses such as starch, flour, ethanol, cooking oil, frying and crisps. In addition, sweet corn is produced for human consumption as either a fresh or processed product. The kernels of sweet corn are translucent and more or less wrinkled at maturity. Sweet corn, before it is ripe and dry, has a sweeter taste than do other types because the endosperm contains sugar as well as starch. Sweet corn is favorable for fresh consumption because of its delicious taste, delicate crust and soft and sugary texture compared to other corn varieties.

Sweet corn is produced to meet market demand in

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cream-style, whole kernel canning and frozen-style corn. A small percentage of sweet corn is produced for the fresh market. Sweet corn consumption has increased considerably over the past 30 years world-wide. Consumption in Turkey has recently increased in coastal and tourist areas. Sweet corn is an important export crop, and acreage fluctuates from year to year in response to variable export market demand and market price. Due to its early maturation, sweet corn is very suitable for crop rotations. Early harvested plants can also be used as a green forage crop. Sweet corn does have some specific environmental and cultural needs in the Southeastern Anatolia region, such as a planting time that must be met for the plant to produce high, marketable yields.

Preliminary investigations conducted by Öktem and Öktem (1999a) showed that it is highly feasible to grow sweet corn in Southeastern Anatolia, where agricultural and irrigation projects are being implemented regionally.

Two important components of corn cropping systems are plant population and planting date. Proper selection of these and other cropping-system components can optimize corn yield. The influence of sowing date on crop development and yield of maize was studied during 1983-85 at Arlington, Wisconsin. Sowing dates were April 26 to May 6 (early), May 14 to 19 (middle), and May 27 to June 6 (late). The highest grain yields were generally obtained when planting was completed by early May, with yield declining as planting was delayed (Imholte and Carter, 1987).

Three cultivars were evaluated for yield and yield components at Guaiba at 2 sowing dates (October 10 and November 1). With delayed sowing, decreases were observed in yield (by 9%). Ear kernel numbers were not affected by planting date (Noldin and Mundstock, 1988). Carter (1984) stated that the highest corn grain yield in the northern U.S. Corn Belt was obtained by planting during late April or early May. Yield reductions increase progressively as planting is delayed throughout May and early June.

Herbek et al. (1986) emphasised that a yield increase trend was observed as planting date progressed from the first planting date (late April) to the second (mid-May). Yield increased with delayed planting dates. Erbay and Köycü (1986) reported that the highest yield was obtained from the Akpınar variety sown on the May 3 and that yield decreased as planting time was delayed. Ergin et al. (1989) stated that the highest yield was obtained from the sowing at the end of May. Yield and tasseling period decreased with the delay in sowing dates.

In order for crops to best utilize moisture, nutrients and solar radiation, they must be grown from an optimum sowing date. The objective of this research was to determine the most suitable sowing date in approximately 3.5 month period from April 25 to 25 May as a first crop and from June 10 to August 10 as a second crop for sweet corn production in semi-arid regions like Southeastern Anatolia.

Materials and Methods

Materials

This study was conducted during 2000 and 2001 at the Field Research Facility of the Faculty of Agriculture at Harran University, Şanlıurfa, Turkey. The experimental field is located on the Harran Plain (altitude: 465 m; 37° 08' N and 38° 46' E) where the climate varies from arid to semi-arid. The weather is hot and dry from May to September, when temperatures can reach up to 46 °C, and is usually warm during the winter. An average of 460 mm of rain falls each year and the relative humidity averages about 49%.

Table 2 provides the climatic data for the Meteorological Station of Şanlıurfa. As can be seen from Table 2, in June, July and August for both treatment years the temperatures were all above 40 °C while the relative humidity was below 50%. Except for August and September 2000 (0.7 and 1.6 mm, respectively), no rainfall was observed from June to September in the treatment years. During the periods in the treatments, the weather conditions were hot and dry and the relative humidity was very low.

In both years, soil samples were taken one day prior to seeding, and were analyzed using the method described by Jackson (1960). Some chemical characteristics and other features of the experimental area are given in Table 1. The soil of the research field was clay. The field capacity of the soil was 33.8% in a dry basis, the permanent wilting point was 22.6% and the volume weight of the soil was 1.41 g cm^{-3}.

The Merit variety was used as the crop material. Merit is a hybrid (F1) single cross sweet corn (*Zea mays* L. *saccharata* Sturt.) variety which is produced by May Seed Co. Ltd.

Table 1. Some chemical characteristics of the research area soil.

Depth (m)	$CaCO_3$ (%)	Total Salt (%)	pH	Org. Matter (%)	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
0-0.3	27.6*	0.074	7.7	1.3	22	28	1280
	26.1	0.078	7.6	1.1	28	26	1370
0.3-0.6	29.8	0.074	7.8	0.9	11	15	900
	25.5	0.071	7.7	0.8	13	24	840
0.6-0.9	34.7	0.070	7.2	0.7	5	12	830
	33.0	0.073	7.1	0.6	8	19	790

* Upper and lower rows are 2000 and 2001 values, respectively.

Table 2. Monthly climate data during the growth period of sweet corn in 2000 and 2001 in Şanlıurfa†.

Months	Temperature (°C)						Mean relative humidity (%)		Total precipitation (mm)	
	Maximum		Minimum		Mean					
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
January	20.5	17.4	-2.4	0.0	4.9	7.9	74.3	63.0	127.2	14.0
February	16.6	20.4	-1.5	-3.3	6.6	8.1	63.0	62.2	42.8	92.1
March	25.5	25.2	-0.6	6.3	10.3	14.6	55.2	58.7	31.5	66.9
April	29.6	31.6	6.1	7.4	17.8	17.2	56.8	60.6	18.3	59.9
May	35.3	35.8	10.6	9.3	23.1	20.1	41.0	52.8	3.3	50.6
June	40.0	40.4	18.5	17.2	29.2	29.2	36.7	28.7	-	-
July	46.8	44.0	22.7	22.2	34.8	32.8	33.4	32.9	-	-
August	43.0	42.4	20.4	21.1	31.3	31.5	43.0	41.9	0.7	-
September	38.2	38.0	13.8	14.8	26.4	27.5	46.1	42.4	1.6	-
October	31.6	33.6	9.4	9.5	19.1	20.6	54.4	52.1	7.6	42.1
November	26.2	26.5	5.7	-0.4	14.4	11.6	52.9	61.2	69.1	41.7
December	18.0	16.2	1.0	-2.1	8.0	7.6	71.7	81.4	85.8	179.1

†: Data collected from Şanlıurfa Meteorological Station.

Methods

The experiment was set up as a randomized complete block experimental design with 3 replications. Sowing dates were April 25, May 10, May 25, June 10 (first crop sowing dates), and June 25, July 10, July 25 and August 10 (second crop sowing dates). Each plot area was 14 m^2 (5 m x 2.8 m) and consisted of 4 rows. Distance between rows was 70 cm and intra row spaces were 22 cm.

Land was plowed and cultivated then prepared for planting with a single pass of a disk-harrow. At sowing, 100 kg ha^{-1} pure N, P and K (15-15-15 composite) was applied to each plot and this was followed by 200 kg ha^{-1} N as urea (46% N) at the 6 leaf stage (Öktem and Öktem, 1999a). The banded fertilizer was 50 mm to the side and 50 mm below the seed.

The seeds were sown at a 5-6 cm depth. In both years, irrigation water was first applied to all treatments

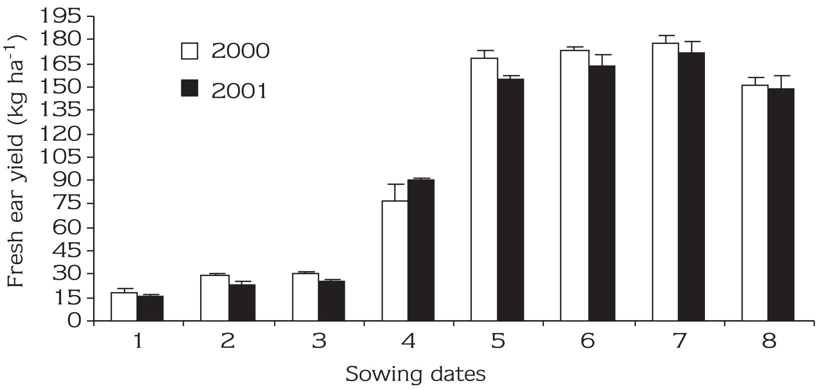

Figure 1. Fresh ear yield values at different sowing dates during 2000 and 2001. 1: April 25, 2: May 10, 3 : May 25, 4 : June 10, 5 : June 25, 6 : July 10, 7 : July 25, 8 : August 10 sowing date. Vertical bars indicate standard errors of the mean.

using a sprinkler irrigation system. After the emergence of plants, plots were irrigated equally by the furrow irrigation system. Irrigation water was applied as required to prevent the occurrence of moisture stress in the crop. When the kernel moisture was about 72% (Olsen et al., 1990), ears from 2 rows in the center of each plot were harvested manually. Data were not collected for the outer rows in each plot to avoid any border effect. Then all ears were collected from the center, 2 rows from each plot. Collected ears for the determination of fresh ear yield values were husked off. Kernel moisture was determined using a microwave drying method (Becwar et al., 1977). After determination of fresh ear yield values, 20 ears without husks were selected randomly from every plot; ear diameters, kernel numbers per ear and single fresh ear weight values were measured. Husk ratio values were determined (husk ratio (%) = husk weight / ear weight with husk x 100).

Analysis-of-variance (ANOVA) was conducted on the data for both years and least significant difference (LSD) tests were used (Cochran and Cox, 1957) to determine differences among sowing dates using Mstat-C™ statistical software.

Results and Discussion

Mean squares from the analysis of variance for the sowing dates for the duration of tasseling, ear diameter, kernel numbers per ear, single fresh ear weight, husk ratio and fresh ear yield per unit area values are given in Table 3. According to variance analysis, sowing dates were significant for all characteristics in both years .

Fresh ear yield

The highest fresh ear yield was from the July 25 (177.51 and 172.30 kg ha^{-1}) sowing date, whereas the lowest value was observed from the April 25 (18.24 and 15.53 kg ha^{-1}) sowing date in both years. As can be seen from Table 4, low fresh ear yield values were obtained from the first crop sowing dates (April 25-May 25), and second crop sowing dates (June 10-August 10) gave high fresh ear yield values. High fresh ear values were determined from the June 25 and later sowing dates. Yield was low in the first crop sowing dates due to pollination and fertilization problems. Maddonni et al. (1998) stated that environmental conditions may affect kernel biomass accumulation in each phase. Temperature and photoperiod are the 2 most important environmental variables influencing the rate of development in maize. Although Şanlıurfa has a 224 days growing period (Kün and Emeklier, 1987) for corn production as a first or second crop, the first crop fails due to high temperature and low air humidity at flowering (Çölkesen et al., 1997; Öktem, 1999b).

Martin et al. (1976) stated that the production of corn requires a mean summer temperature of 21 to 27 ^{o}C, and a mean night temperature exceeding 13 ^{o}C. Corn is grown extensively in hot climates, but yields are reduced where the mean summer temperatures are above about 27 ^{o}C. Cold weather retards the shedding of pollen, while hot dry conditions tend to hasten it.

Table 3. Mean squares from the analysis of variance for sowing date on duration of tasseling, ear diameter, kernel number per ear, single fresh ear weight, husk ratio and fresh ear yield.

Source of variation	Df	Mean square					
		Duration of tasseling	Ear diameter	Kernel number per ear	Single fresh ear weight	Husk ratio	Fresh ear yield
2000							
Replicate	2	10.667	3.015	956.980	18.107	19.103	1.280
Sowing time	7	69.024**	327.002***	157109***	28142.5***	768.060***	15239***
Error	14	10.667	3.618	445.053	189.715	8.568	27.77
Total	23	28.428	101.987	48170.030	8682.174	240.634	4654.859
2001							
Replicate	2	2.625	0.754	803.760	567.5	49.06	5.715
Sowing time	7	74.851***	295.398***	139149.9**	20248.6***	882.6***	14211***
Error	14	0.530	4.853	2766.488	455.426	19.738	28.308
Total	23	23.332	92.923	44103.8	6489.2	284.9	4342.849

* : $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$

Table 4. Effect of sowing dates on sweet corn fresh ear yield and single fresh ear weight in 2000 and 2001.

Sowing dates	Fresh ear yield (kg ha^{-1})			Single fresh ear weight (g)		
	2000	2001	Average	2000	2001	Average
1. April 25	18.24 f*	15.53 f	16.89	44.57 e	35.43 e	40.00
2. May 10	29.67 e	23.14 ef	26.41	51.23 e	63.70 de	57.47
3. May 25	30.62 e	25.31 e	27.96	56.87 e	83.20 d	70.03
4. June 10	76.85 d	90.28 d	83.57	105.47 d	126.40 c	115.93
5. June 25	168.14 b	154.23 bc	161.19	228.20 bc	215.50 ab	221.85
6. July 10	173.40 ab	163.00 ab	168.20	248.50 ab	226.00 ab	237.25
7. July 25	177.51 a	172.30 a	174.91	265.30 a	250.00 a	257.65
8. August 10	151.18 c	148.10 c	149.64	221.30 c	190.00 b	205.65
$LSD_{0.05}$	9.228	9.314		24.133	37.391	

* Means within a column followed by the same letter are not significantly different at 5% level according to the LSD test.

Duration of tasseling depends on temperature (Daughtry et al., 1984; Shaw, 1988) and variety. Under proper conditions, this period between tassel flowering and silking is 1-3 days (Kırtok, 1998). The emergence of the silks and silking is delayed by 1-2 weeks under stress conditions (Edmeades et al., 1990) and drought. The corn plants are particularly prone to protandry due to the hot weather at the Southeastern Anatolia region (Öktem, 1997). Protandry is the shedding of pollen before the appearance of the silks. At the stage of pollination and fertilization, corn requires above 60% air humidity (Kırtok, 1998). Ear silks and pollens die with dry and hot weather. Poehlman and Sleper (1996) stated that the pollen vigor period decreases above 35 °C. High temperature and low air humidity cause low kernels on the ear (Shaw, 1988; Kırtok, 1998) and low yield (Dow et al., 1984; Edmeades et al., 1990; Öktem, 1997).

The negative effects of climate hinder early corn sowing (April and May) and this restricts corn planting as the first crop in the region. The Southeastern Anatolia climate is defined as arid to semi-arid. Summers are very hot and dry from May to September and temperatures can reach 46-48 °C and sometimes 52 °C. There is no precipitation during the summer months (June, July, August). Average relative humidity during the summer is around 30-35 %. In addition, there is a warm wind that blows from the south and this causes the corn flowers to dry. Depending on the sowing date the first sown corn plants give tassel flowering between July and early August. At the same as the highest temperature prevails. There are also the lowest humidity and hot dry winds. Because of these negative climatic factors, pollens die, fertilization fails and kernels do not occurred on the ear. Therefore corn is not grown as a first crop at this time in Southeastern Anatolia.

With the second crop sowing dates tassel flowering begins on August 20 and later. During this period no fertilization problem was observed due to the decrease in temperature. Thus, sweet corn can be sown for fresh ear yield between June 25 and August 10. In particularly, income can be increased with the autumn harvest.

Similarly, the August 25 sowing date was researched in this study. Unfortunately, no tassel flowering or yield occurred with the August 25 sowing date under field conditions and plants were negatively affected by the early autumn cold and rainy weather. Delays in sowing date accelerated hastened development between seedling emergence and silking, reducing cumulative incident radiation on the crop during the vegetative period. However, late sowing increased the crop growth rate during the vegetative period because of high radiation use efficiency and a higher percentage of radiation interception. Conversely, late sowings decreased crop growth rate during grain filling because of low radiation use efficiency and low incident radiation (Cirilio and Andrade, 1994a).

Environmental conditions may have reduced photoassimilate production during the lag phase of late-sown maize, because both temperature and incident solar radiation were low at that time, affecting biomass production and perhaps sink activity (Ou-Lee and Setter, 1985). Lower solar radiation may result in grain growth in excess of biomass production (Ruget, 1993), indicating a possible source limitation. On the other hand, low temperature may have a negative effect on kernel weight and kernel numbers per ear through reductions in both radiation - use efficiency (Andrade et al., 1993) and biomass partitioning to the grains (Wilson et al., 1995). Some researchers stated that delaying the sowing date resulted in decreased yields (Ishimura et al., 1984; Tomorga et al., 1985; Imholte and Carter, 1987), whereas Herbek et al. (1986) reported that yields increased with a delayed sowing date.

Sweet corn must be harvested within a very short time after optimal maturity, so planting dates may be staggered over a period of weeks to permit a longer harvest period. Because of the long summer, sweet corn can be sown between June 25 and August 10 for fresh ear yield in Şanlıurfa and similar Southeastern Anatolia regions. In the light of the research results, the best sowing period for sweet corn fresh ear production is determined from June 25 to July 25.

Single fresh ear weight

Single fresh ear weight ranged from 44.57 g to 265.30 g and from 35.43 to 250.00 g in 2000 and 2001, respectively. In both years, as can be seen from Table 4, the lowest and highest single fresh ear yield values were observed at the April 25 and July 25 sowing dates, respectively. Earlier sowing dates than June 25 gave low single fresh ear weight values (first crop), and late sowing dates than June 25 gave high single fresh ear weight values (second crop). Sencar et al. (1997) stated that single ear weight increased with delayed sowing time. Single fresh ear weight values were low due to lower kernel numbers per ear. The lack of kernels caused a loss of marketable value due to fertilization problem at the June 10 and earlier sowing dates.

As climatic conditions become more adverse, the ears became shorter, the kernels shallower and the yield lower (Martin et al. 1976). Environments with low air temperatures (<19 °C) and less incident solar radiation lead to a smaller final kernel weight due to reductions in photoassimilate production and its partition to the grains (Maddonni et al., 1998).

Duration of tasseling

Duration of tasseling ranged from 48.0 days (July 25) to 63.0 days (August 10) in 2000 (Table 5). The earliest tasseling was on the June 25 (46.3 days), July 10 (47.7 days) and July 25 (46.3 days) sowing dates, whereas the April 25 (59.3 days) and August 10 (57.3 days) sowing

Table 5. Effect of sowing dates on duration of tasseling and ear diameter in 2000 and 2001.

Sowing dates	Duration of tasseling (day)			Ear diameter (mm)		
	2000	2001	Average	2000	2001	Average
1. April 25	60.0 ab*	59.3 a	59.65	31.17 d	26.33 d	28.75
2. May 10	56.0 bc	55.0 c	55.50	28.90 de	27.63 d	28.27
3. May 25	54.0 c	51.7 d	52.85	29.17 de	28.00 d	28.58
4. June 10	55.0 bc	51.3 d	53.15	27.63 e	36.93 c	32.28
5. June 25	56.0 bc	46.3 f	51.15	36.83 c	39.90 c	38.37
6. July 10	51.0 cd	47.7 e	49.35	43.27 b	43.83 b	43.55
7. July 25	48.0 d	46.3 f	47.15	51.80 a	48.67 a	50.15
8. August 10	63.0 a	57.3 b	60.15	53.13 a	51.90 a	52.52
$LSD_{0.05}$	5.722	1.275		3.33	3.860	

* Means within a column followed by the same letter are not significantly different at 5% level according to the LSD test.

dates had the latest values in 2001. Ergin et al. (1989) reported that the tasseling period decreased with the delaying sowing dates.

Duration of tasseling was affected by temperature and radiation depending on day length. Tasseling was delayed in the short days and low temperature conditions of the April 25, May 10 and August 10 sowing dates, whereas the tasseling period was shorter at the other sowing dates due to long days and high temperature. The duration of tasseling increased at the latest and earliest sowing dates. Corn is a short-day plant, i.e. flowering is hastened and vegetative growth retarded by long nights. Long days increase the leaf number, plant size, and the length of the growing period of corn. When the days are shorter, plants mature quickly with reduced plant growth (Martin et al, 1976). Tollenaar (1999) reported that duration from sowing to tasseling in maize increases when the photoperiod is increased during the photoperiod-sensitive phase.

Ear diameter

The highest ear diameter values were determined at the July 25 and August 10 sowing dates whereas ear diameter values were low at early sowing dates in both years (Table 5). Ear diameter increased with delayed sowing date. Pollination and fertilization problems were observed between the April 25 and June 10 sowing dates. Few kernels formed on the ear at the April 25, May 10 and May 25 sowing dates. Because of fertilization problems observed at the early sowing dates, ear diameter values were low at these sowing dates whereas ear diameter values were high at later sowing dates.

Kernel number per ear

In both years, kernel number per ear values were very low between the April 25 and May 25 sowing dates, whereas these values were high between the June 25 and August 10 sowing dates (Table 6). Although kernel number per ear values for the June 10 sowing date were lower than those of the June 25 and later sowing dates, they were higher than those of the April 25, May 10 and May 25 sowing dates in both years. In addition, kernel number per ear values were very low at early sowing dates due to fertilization problems. Noldin and Mundstock (1988) showed that kernel number per ear were not affected by planting date.

Reductions in crop growth rate after silking determined decreases in the number of grains set per ear, whereas reductions in the number of ears were not associated with crop growth rate in the presilking period, in which an important allocation of assimilates to structural vegetative growth and maintenance respiration in late sowings would be associated with high ear barrenness (Cirilio and Andrade, 1994b). Decreased incidence of solar radiation reduced final kernel weight through reductions in biomass production per kernel, but low temperatures may have also impaired grain filling through reductions in biomass partitioning to kernels.

Husk ratio

Husk ratio values were close to each other in both research years (Table 6). Husk ratio values varied from 25.6% (July 25) to 62.6% (April 25) and from 25.1% (August 10) to 68.5% (April 25) in 2000 and 2001, respectively. The husk ratio was higher due to low kernel numbers on ears at the first crop sowing dates, which occurred due to fertilization problems. Fertilization problems were not seen at the second crop sowing dates (June 25-August 10). Kernels were regular and perfectly located in the ear and the husk ratio was low. When the amount of kernels on the ear was low, the husk ratio increased, while the inverse husk ratio decreased.

Conclusion

Consequently, high fresh ear yield values were obtained from the June 25 to August 10 sowing period (second crop period) in semi-arid field conditions in the Southeastern Anatolia region. The negative effects of the climate hinder the earlier sowing of corn (April and May) and this restricts corn planting as first crop in the region. High temperature (upper 40 °C), low air humidity (35%), and hot dry winds cause fertilization problems in corn during the first crop period (from April 20 to June 10) in the Southeastern Anatolia region. Fresh ear yield values were very low at the first crop sowing dates. First crop sweet corn production is not possible in the near future in the region. On the other hand, 1.7 million hectares of lands will be irrigated in Southeastern Anatolia under the Southeastern Anatolia Project. If relative air humidity increases up to 60% due to increasing irrigated areas, fertilization problems may not be seen at first crop production. Our results suggest that optimal sowing dates for sweet corn could be from June 25 to July 25 in Şanlıurfa and similar Southeastern Anatolian regions.

Table 6. Effect of sowing dates on kernel number per ear and husk ratio in 2000 and 2001.

Sowing dates	Kernel number per ear (number/ear)			Husk ratio (%)		
	2000	2001	Average	2000	2001	Average
1. April 25	8.00 d*	13.67 e	10.83	62.63 a	68.50 a	65.57
2. May 10	12.00 d	15.00 e	13.50	62.37 a	65.10 a	63.73
3. May 25	23.67 d	151.33 d	22.25	56.60 b	55.37 b	55.98
4. June 10	242.33 c	275.67 c	259.00	49.80 c	44.43 c	47.12
5. June 25	430.20 b	446.83 b	438.52	30.93 d	32.57 de	31.75
6. July 10	452.37 b	495.17 ab	473.77	31.40 d	33.30 d	32.35
7. July 25	567.67 a	554.70 a	561.18	25.60 e	27.20 de	26.40
8. August 10	419.70 b	419.80 b	419.75	28.20 de	25.10 e	26.65
$LSD_{0.05}$	36.963	92.156		5.129	7.784	

* Means within a column followed by the same letter are not significantly different at 5% level according to the LSD test.

References

Andrade, F.H., S.A. Uhart and A. Cirilio. 1993. Temperature affects radiation use efficiency of maize. Field Crops Res. 32: 17–25.

Becwar, M.R., N.S. Mansour and G.W. Varseveld. 1977. Microwave drying: A rapid method for determining sweet corn moisture. Hort. Science 12: 562-563.

Carter, P.R. 1984. Optimum corn planting practices. Univ. of Wisconsin Ext. Pub. A3264.

Cirilio, A.G. and F.H. Andrade. 1994a. Sowing date and maize productivity: I. Crop growth and dry matter partitioning. Crop Science, 34: 1039-1043.

Cirilio, A.G. and F.H. Andrade. 1994b. Sowing date and maize productivity: II. Kernel number determination. Crop Science, 34: 1044-1046.

Cochran, W. and G. Cox. 1957. Experimental Design John Wiley & Sons Inc., New York.

Çölkesen, M., A. Öktem, C. Akıncı, İ. Gül, R. İri and R. Kaya. 1997. Şanlıurfa ve Diyarbakır koşullarında bazı mısır çeşitlerinde farklı ekim zamanlarının verim ve verim komponentleri üzerine etkisi. Türkiye II. Tarla Bitkileri Kongresi, 22-25 Eylül 1997, s: 139-142a, Samsun.

Daughtry, C.S.T., J.C. Cochran and S.E. Holinger. 1984. Estimating silking and maturity dates of corn for large areas. Agron. J. 76: 415-420.

Dow, E.W., T.B. Daynard, J.F. Muldoon, D.J. Major and G.W. Thurtell. 1984. Resistance to drought and density stress in Canadian and European maize hybrids. Canadian J. Plant Sci. 64: 575-585.

Edmeades, G.O., J. Bolanos and H.R. Lafıtte. 1990. Selecting for drought tolerance in maize adapted to the lowland tropics. The 4th Asian Regional Maize Workshop, Sept. 23-27, Islamabad, Pakistan.

Erbay, S. and C. Köycü. 1986. A study on the variety and sowing time of corn under the ecological conditions of Samsun. O.M.U. Zir. Fak. Derg. 1: 35-38.

Ergin, İ., M. Tosun, H. Soya. 1989. Üç mısır çe?idinde farklı ekim zamanının dane verimi ve bazı verim karakterleri üzerine etkisi. Ege Üniv. Zir. Fak. Dergisi 26: 159-169.

Herbek, J.H., L.W. Murdock and R.L. Blevins. 1986. Tillage system and date of planting effects on yield of corn on soils with restricted drainage. Agron. J. 78: 824-826.

Imholte, A.A. and P.R. Carter. 1987. Planting date and tillage effects on corn following corn. Agron. J. 79: 746-751.

Ishimura, I., E. Sawazaki and M. Moda. 1984. Assessment of green maize cultivars in the region of Valedo Ribeive. Exp. De Pariquera Inst. Agron. 40, 5p, Brazil.

Jackson, M.L. 1960. Soil Chemical Analysis. Prentice-Hall Inc. Englewood Cliffs, New Jersey, U.S.A.

Kırtok, Y. 1998. Mısır Üretimi ve Kullanımı. Kocaoluk Yayınevi, İstanbul.

Kün, E. and Y. Emeklier. 1987. İklim faktörleri bakımından Türkiye'de mısır üretim olanakları. Türkiye'de Mısır Üretiminin Geliştirilmesi, Problemler ve Çözüm Yolları Sempozyumu, s: 86-123, 23-26 Mart, Ankara.

Maddonni, G.A., M.E. Otegui and R. Bonhomme. 1998. Grain yield components in maize II. Post silking growth and kernel weight. Field Crops Res. 56: 257-264.

Martin, J.H., W.H. Leonard and D.L. Stamp. 1976. Principles of Field Crop Production. Third edition. Macmillan Publishing Co. Inc., New York.

Noldin, J.A. and C.M. Mundstock. 1988. Grain yield and yield components of three maize cultivars at two sowing dates. Pesquisa Agropecuaria Brasileria 23: 615-620.

Olsen, J.K., J.E. Giles and R.A. Jordan. 1990. Post-harvest carbohydrate changes and sensory quality of three sweet corn cultivars. Scientia Horticulture, 44: 179-189.

Ou-Lee, T.M. and T.L. Setter. 1985. Effect of increased temperature in apical regions of maize ears on starch-synthesis enzymes and accumulation of sugars and starch. Plant Physiol. 79: 852-855.

Öktem, A. 1997. GAP bölgesinde mısır üretim olanakları. Harran Üniversitesi Ziraat Fakültesi Dergisi, 1: 113-122.

Öktem, A. and A.G. Öktem, 1999a. Bazı şeker mısır çeşitlerinin (*Zea mays* L. *saccharata* Sturt.) firik koçan ve tane verimleri ile önemli tarımsal karakterlerinin belirlenmesi. GAP I. Tarım Kongresi, s: 893-900, 26-28 Mayıs 1999, Şanlıurfa.

Öktem, A. 1999b. GAP bölgesinde iklim faktörlerinin mısır yetiştiriciliğine etkileri. GAP I. Tarım Kongresi, s: 743-750, 26-28 Mayıs 1999, Şanlıurfa.

Poehlman, J.M. and D.A. Sleper, 1996. Breeding Field Crops. Iowa State University Press/Ames, p. 494, USA.

Ruget, F. 1993. Contribution of storage reserves during grain filling of maize in Northern European conditions. Maydica 38: 51-59.

Sencar, Ö., S. Gökmen and M. ?di. 1997. Effects of sowing date and growing methods on some characters of sweetcorn (*Zea mays* L. var. *saccharata*). Turkish Journal of Agriculture and Forestry 21: 65-71.

Shaw, R.H. 1988. Climate Requirement. In: Corn and Corn Improvement, 3rd ed. (Ed. G. F. Sprague and J.W. Dudley), No:18, ASA, Madison, Wisconsin.

Tollenaar, M. 1999. Duration of grain-filling period in maize is not affected by photoperiod and incident PPFD during the vegetative phase. Field Crops Res. 62: 15-21.

Tomorga, P., F.F. Mihaailescu and C. Chimisliu. 1985. Research on establishing the optimum sowing date for new maize hybrids grown in Dobrogea under irrigation. Productia Vegetale Cereale Si Plante Technice 37: 3-7, Romania.

Wilson, D.R., R.C. Muchow and C.J. Murgatroyd. 1995. Model analysis of temperature and solar radiation limitations to maize potential productivity in a cool climate. Field Crops Res. 43: 1-18.