Determination of Arid and Temperature Resistant Sweet Corn (*Zea mays saccharata Sturt*) Lines

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Abstract— *The objective of the present study is to identify aridity and temperature resistant sweet corn variety candidates and to provide resource material for development of new hybrid varieties. The research was designed as three-peat random blocks experimental design in Siirt and Sakarya locations in 2014, and irrigation application was conducted with drip irrigation method. Mean plant water consumption in control (I_{100}) was 808 mm and 633 mm in Siirt and Sakarya, and the mean irrigation water amount was 684 mm and 138 mm, respectively. The statistical significances of differences among soil moisture content, chlorophyll-meter value, crop water stress index, fresh corncob, and grain yield were investigated. The arid and temperature resistant sweet corn line was determined according to soil moisture content, chlorophyll-meter value, and crop water stress index. The most arid and temperature resistant corn line, variety line #2, had the lowest moisture content and crop water stress index value but the highest chlorophyll-meter value. We found that to determine the arid and temperature resistant corn lines, soil moisture content values can also be used together with chlorophyll-meter values and crop water stress index.*

Keywords— Sweet corn, yield, soil moisture, drought.

I. INTRODUCTION

Sweet corn is one of the horticultural crops and fresh ears have consumed the most. Fresh ear yield or dry grain yield are considered as yield components of such a crop (Hirich et et al., 2014).It has yellow, white and bicolored ear types. Cultivars are classified as early, mid, and late season, depending on their maturity days and late season cultivars in general are the highest quality (Lerner & Dana,1998).Corn yield and quality are mainly affected by environmental, cultural and genetic factors of cultivars (Carpıcı et al., 2010).In an area where there is no water shortage, full irrigation results in maximum production. In regions with limited water supply, deficit irrigation could be very beneficial to improve water use efficiency and irrigated lands with same amount water. In addition, deficit irrigation technique may increase the net income of farmers by increasing the crop production per unit water applied (Galavi & Moghaddam 2012) and is now studied world wide as one of the practices to save water (Periera et et al., 2002). Even Hirich et al. (2014) reported that with regards to yield and saving water, 75% of full irrigation was optimal treatment for sweet corn crop. Under deficit irrigation, crop production per unit area is less than the maximum yield per unit area, but net profit is higher (Mohammadpour et al. 2013).

In that context, the importance of the studies that aim to develop new varieties, tolerant to drought and heat is becoming more important. Although Turkey has suitable ecological regions to grow sweet corn, so far no comprehensive studies indicating which sweet corm varieties are high efficiency were performed under drought stress conditions.

Since sweet corn is a summer plant, heat and aridity that occur during the growth season are among the most important abiotic stresses that limit the sweet corn production. Based on different years, these negative stress conditions could cause significant loss in sweet corn yield. This fact makes it necessary to determine the resistance of sweet corn varieties and variety candidates that are resistant to aridity and could adapt to different ecological regions in Turkey. Thus, a need for a study such as the present one, which would determine aridity resistant sweet corn variety candidates and obtain heat and aridity resistant genotypes, has arisen. The objective of the study is to identify aridity and temperature resistant sweet corn variety candidates and to provide resource material for development of new hybrid varieties. For this purpose, the resistance of sweet corn variety candidates and genotypes against aridity stress, their soil moisture and chlorophyll content during the growth season, and their crop water stress index (CWSI) values were monitored and identified. The variety candidate with the lowest soil moisture content, CWSI value, and that utilized the irrigation water with optimum efficiency was considered as the most resilient against aridity stress.

The other main goal of the study is to analyze yield, irrigation water requirements, crop water consumption comparatively of our original sweet corn lines for Siirt and Sakarya provinces of Turkey.

II. MATERIALS AND METHODS

The plant material consisted of four homozygote sweet corn variety lines (no.1, no.2, no.3, no.4) and two standard sweet corn varieties (no.5, no.6) that belong to Sakarya Corn Agricultural Research Institute. The study was conducted in 2014growth season in two different locations: Agricultural Research and Experimental Station of Siirt University,and in Sakarya province. Siirt province,894 m above the sea level, is located at37˚ 56' N and 41˚ 57' E with savannah ecology, where it is hot and arid in summers and cold and rainy in winters. Annual average precipitation is about 757 mm with an average temperature of 16.1 °C. However, precipitation is erratic through the year, and almost no precipitation is observed during the growing season. The electrical conductivity of soil in Siirt is low with a slight salinity problem. The soil texture is clayed, with low phosphorus, and high potassium content and moderate organic matter. Field capacity (FC) and permanent wilting point (PWP) are397 mm0.90m^{-1} and277 mm0.90 m^{-1}, respectively with bulk density of 1.45 $grcm^{-3}$.

Sakarya province, 30 m above the sea level, is located at40˚ 46' N and 30˚ 24' E. Black Sea climate prevails in the Black Sea coasts of Sakarya, while the southern part is under the effect of Marmara or Mediterranean climate. Annual precipitation averages, temperature and relative humidity are 800 mm, 14 °C, and 72%,respectively.Excluding years with extremities, seasonal rainfall distribution is generally within optimal limits. Due to sufficient rainfall event in Sakarya province, rainfed farming is widely spread for field crops. The soil of Sakarya province is clay with moderate acid characteristics, moderate organic matter content, no salinity problems, low phosphorus and high potassium content. Field capacity (FC), permanent wilting point (PWP), and bulk density are374 mm0.90m^{-1},224 mm0.90^{-1}, 1.42 gr /cm^{-3}, respectively.

The experiment was based on randomized blocks divided parcels experimental design with three repetitions. Trial consisted of a total of 12 parcelswith2 rows of sweet corn seeds into each parcel, and the parcel size was (1.4x5 m) 7 m^2.

Corn seeds were planted manually at a depth of 4-5 cm with a row spacing of 70 cm, intra row distance of 20 cm, and 25 seeds for each parcel on 19th, April 2014.Following soil fertility analysis, amount of fertilizer needed per hectare was 250 kg pure nitrogen and 90 kg pure phosphor. Half of nitrogen and all the phosphorus were used as seed bed in the form of 20.20.0, while the remaining nitrogen was applied to the top in the form of urea (46%)the plant height reached 40 cm. The phosphorus was applied as seed bed every other year during the seed planting (Anonymous2001a).

During the experiment, 0-90 cm soil depth was considered in irrigation program and irrigation was started when 50% of available water capacity of soil was consumed. Drip system was used and laterals were placed into each row in70 cm intervals. The drippers with in-line types having 33cm apart with a flow rate of4 L h^{-1} were used. The calculated water amount was applied to the parcels by the use of dripper flow rate-time relation. Seven irrigations in Siirt location and one irrigation (138 mm) for Sakarya location were performed, since the precipitation was observed before the start of subject irrigations.

When the crops reached physiologic maturity, crops within the two rows of 5 m length (7 m^2 area) were harvested manuallyin5-7th September, 2014 depending on location. The five plants were selected randomly to measure the plant length, cob height as well as the leaf area. Measurements and calculations were performed as suggested by the Ministry of Agriculture and Rural Affairs' Technical Regulations (Anonymous 2001b).

Gravimetric method was used for soil moisture monitoring. Total applied water was calculated as follows:

$$V= d_T x A$$

The amount of water volume to be applied inthe parcels was calculated by multiplying total water amount with parcel area and cover percentage as follows:

$$V= d_T x A x P$$

Where V is volume of applied water for each parcel (L) and A is parcel size (m^2), and P is coverage percentage (%).

Water use efficiency (WUE) and irrigation water use efficiency (IWUE) were calculated by dividing grain yield to seasonal crop water consumption (ET),and the total applied water, respectively.

Canopy temperature readings were made by infrared thermometer to determine the crop water stress index (CWSI) before and after each irrigation. In addition, leaf canopy temperature readings were taken between08:^{00}to 17:^{00}to determine the hour of the day when the CWSI value was maximum. CWSI measurements were started before and after irrigation, when the plants covered soil surface at about 80%. CWSI was calculated by following equation (Idso et al., 1982):

$$CWSI= [(Tc-Ta)- LL] / UL- LL$$

where, CWSI-crop water stress index, Tc- canopy temperature (°C), Ta- air temperature (°C), LL- lower limit (the limit value, which plants transpire at the potential pace) where there is no stress on the plant, and UL- upper limit (the limit value, which plants are thought not to transpire) where the plants are under the stress completely.

Chlorophyll content was measured indirectly by measuring the chlorophyll amount in the leafvia the portable chlorophyll meter device (Minolta SPAD- 502, Osaka, Japan). Chlorophyll measurements were taken at different periods during the whole growing season, on the leaf closest to the tasselling of 10 corn plants chosen randomly at each parcel, between the hours of 12:^{00}- 14:^{00}under no wind and clear sky conditions.

Those measurements were taken on same leaves before and after the irrigation. When reading is close to one, chlorophyll content increases, when it is about zero, chlorophyll content decreases. The acquired data were subjected to variance analysis using the Jump statistical software package. Following variance analysis, the statistically significant treatments were with LSD test, and each location was evaluated individually. The relationships between the parameters were determined through correlation analysis.

III. RESULTS AND DISCUSSION

Total applied water was 684 mm and 138 mm for Siirt and Sakarya locations, respectively. The reason for that was the fact that Siirt is located within a semiarid climate zone and there was no precipitation during the growing season, leading to a decrease in moisture content in soil profile, hence, more water had to be applied. In Sakarya province, the plant was able to get the required amount of water from precipitation. Applied water for corn plant was reported between 310-1206 mm in the literature (Gençoglan & Yazar, 1999; Simsek & Gerçek, 2005; Igbadun et al., 2008; Mohammad pour et al., 2013). Gençoglan & Yazar (1999) reported that number of irrigations for corn for the first and the second year of research were 6 and 7 with a total of 752 and 823 mm water application, respectively, under full irrigation conditions at Cukurovaplainin of Turkey. Simsek & Gerçek (2005) stated that irrigation water requirement was between 814-1116 mm for the first year, and between 843-1206 mm for the second yearunder Sanlıurfa conditions. In general, applied water by above researchers was higher than the findings of the present study. Those differences might be the result of the differences in crop type and climatic conditions between the regions of study.

Crop water use (ET), based on genotypes, in Siirt conditions, was the highest for variety candidate no.2 with 825 mm, while the lowest value was observed in variety no.5 with 798 mm. On the other hand, the highest ET value in Sakarya conditions was found in variety line no.2 by 657 mm, while the lowest value was observed in variety no.5 with 618 mm (Table 1). In general, ET value was greater in Siirt province than Sakarya province. The possible reason might be that applied water was higher in Siirt location, so the larger volume of the water applied resulted in an increase in ET.

In the research, soil moisture content in any of the variety candidates and standard genotypes in both locations, in general, was never below 50% of the available water capacity of soil at the beginning of the vegetation period, because crops consume less water during this period. Later on however, when they got closer to blossoming, water consumption reached the maximum level, and due to high levels of evapotranspiration, it fell to 50% of the available moisture capacity before the last irrigation. Irrigation was terminated towards the harvest, therefore the soil moisture content of genotypes fell almost to permanent wilting point (Figure 1). At this point, we could say that the irrigation water sensitivity of sweet corn during the blossoming period in semiarid climate conditions is higher than that of grain corn, and that deficit irrigation should not be recommended for sweet corn in places with such climate conditions. It was observed that even a water deficiency of 10% resulted in low yields such as 15% yield reduction. If the deficit irrigation is performed during the blossoming period these rates became even higher, rising up to 35-40%. Regarding water consumption values; Camoglu et al. (2011) reported that ET values under Çanakkale conditions in 2007 were 50-373 mm, and 201.4-423.0 mm in 2008, Oylukan & Gungor (1975), in their study under Eskişehir conditions, reported that was725 mm. Gunbatılı (1979), reported that the water consumption of corn was 569-670 mm in Tokat–Kozova, Oktem et al. (2008), for the first year of their study in Şanlıurfa conditions, reported 610-876 mm, and 612-889 mm in second year depending on water applied, while Kırnaket al. (2003), in Harran Plain conditions, reported 1320 mm for the first year, and 1435 mm for the second year. Pandey et al. (2000),reported the seasonal water use of corn as 641-668 mm for irrigation treatment with no water deficiency condition, while Kaman (2007), for the first year of his study, reported 562 mm forP31G98 variety, and 405 mm as the lowest crop water consumption level for Tietar variety; while for the second year, he reported the highest crop water consumption level in P31G98 variety as 580 mm, and the lowest crop water consumption level value in Rx. 9292 variety as 421 mm. Our results generally supported the previous work by the above mentioned authors.

Examination of the Siirt location showed that the highest grain yields were found as 8039 and 7356 kg ha^{-1} in no.5 and no.2 lines. The lowest yield was obtained as 4165 kg ha^{-1} in line no.1. In Sakarya province on the other hand, the highest yields were obtained as 8896 and 8141 kg ha^{-1} in no.5 and no.2 lines. The lowest yield value was 5279 kg ha^{-1}in no.4 genotype. There was a significant difference between the two locations. In general, yield obtained from the Sakarya province was higher than yield of Siirt province. The possible reason might be no water deficiency was present in the water deficit sensitivity period within the crop root zone. It means that water deficiency effect on sweet corn grain yield depends on the crop growth stages. Among sweet corn species, several authors stated that there are remarkable differences in terms of grain yield. Bozokalfa et al.(2004) found the grain yield under Aegean Region conditions as 12410-16100 kg ha^{-1}, Esiyok et al. (2004) under Aegean Region conditions as 16450-22170 kg ha^{-1}, Oktem & Oktem (2006) under Harran plain conditions as 8380-16370 kg ha^{-1}. Our findings were generally lower than those previous study results. This could be the result of crop variety and environmental conditions. In corn production, yield is the most important economic factor. However, yield varies depending on genetic potentials of species, as well as environment and planting techniques (Precheur et al., 2006; Sakin et al., 2011).

In Siirt location, the highest water use efficiency, WUE, was obtained from genotypes no.5 as 1.0 kg m^{-3}or no. 2 as 0.90 kg m^{-3}.The lowest water use efficiency was in genotypes no.1 as 0.52 kg m^{-3} and no.4 as 0.59 kg m^{-3}. In Sakarya location, the highest WUE was obtained from genotypes no.5. The lowest WUE was calculated from genotypeno.1 as 0.75 kg m^{-3}. Similar results were reported by Bozkurt et al. (2011). Those results indicated that water use efficiency increases with the decrease of applied water by irrigation as suggested by Junior & Chaves (2014) and Saberi et al. (2012). Deficit irrigation results in higher grain yield or WUE since ET value was lower, which led to a greater WUA.

Under full irrigation, the maximum irrigation water use efficiency, IWUE, was observed in genotypes no.5 as 1.1 kg m^{-3} andno.2 as 1.0 kg m^{-3}. In Siirt location, the lowest WUE was found in genotype no.1as 0.60 kg m^{-3}.In Sakarya location, the highest IWUE was observed in genotypes no.5 as 6.37 kg m^{-3} and no. 2 as 5.55 kg m^{-3}. The lowest IWUE was found in genotype no.4 as 3.81kg m^{-3}. The IWUE in Sakarya province gave better results than Siirt due to more precipitation amount throughout the growing season, as well as the fact that only a single irrigation was performed. IWUE value was calculated higher in Sakarya province than Siirt province, since the lower amount of water application in Sakarya province resulted in better IWUE.

TABLE 1
SWEET CORN GRAIN YIELD, APPLIED WATER, ET, WUE, IWUE, LAI, CWSI, CHLOROPHYLL CONTENT, WITH SOME YIELD COMPONENTS.

Locations	Genotypes	Grain yield (kg ha $^{-1}$) **	Number of Flowering Days (Days)**	Plant height (cm)**	Ear height (cm)**	Ear diameter (cm)**	Irrigation water (mm)	ET (mm) **	WUE (kg /m ^{3}) **	IWUE (kg/ m ^{3}) **	Fresh ear yield (kg/ha)**	Leaf area index (LAI)**	Crap water stress index (CWSI) **	Content of chlorophyll (spad)**
Siirt location (I_{100})	1	4165d	48b	165c	43b	3.73c	684	805cd	0.52c	0.60d	9900c	4.56b	0.44a	56.7d
	2	7350ab	58a	207b	64a	4.00b	684	825a	0.90a	1.0a	15190ab	5.06a	0.13d	61.5a
	3	5913c	58a	220ab	67a	4.06b	684	815b	0.73b	0.86b	16530a	4.82a	0.19c	57.7c
	4	4761cd	57a	231a	72a	4.03b	684	808bc	0.59c	0.70c	14660ab	4.76a	0.14d	56.4e
	5	8039a	58a	232a	68a	3.96b	684	798d	1.00a	1.1a	13900b	4.55b	0.26b	58.2c
	6	6059bc	59a	225a	71a	4.26a	684	802cd	0.76b	0.89b	15900ab	4.41c	0.21c	59.2b
Average		6047	56	214	64	4.01	684	808	0.75	0.87	14350	4.69	0.22	58.1
C. V. (1%)		10.8	2.27	3.68	6.8	1.56		0.65	6.93	0.65	8.1	3.83	9.0	0.53
LSD (0.05)		130.6	3.58	14.28	8.0	0.12		9.5	0.1	0.1	213	0.32	0.040	0.56
Sakarya location (I_0)	1	4628d	52d	190d	52d	3.97d	138	619cd	0.75e	3.20e	12270c	5.17a		60.3d
	2	8141ab	61c	244c	61c	4.30bc	138	657a	1.25b	5.55b	18000ab	5.10a		64.3a
	3	6749bc	61c	255b	61c	4.40b	138	635b	1.06c	4.74c	19570a	4.85b		60.7cd
	4	5279d	62b	268a	62bc	4.30bc	138	628bc	0.84d	3.81d	16470b	4.79b		58.3e
	5	8896a	63ab	271a	63ab	4.23c	138	618d	1.43s	6.37a	16190b	4.57c		61.3c
	6	6711c	63a	248bc	63a	4.70a	138	636b	1.06c	4.76c	19330a	4.45c		62.3b
Average		6734	60	246	60	4.32	138	633	1.07	4.78	16980	4.82		61.2
C. V. (%1)		10.5	1.0	2.0	6.9	1.84		1.0	3.87	5.72	6.3	2.01		0.80
LSD (0.05)		141.2	1.1	8.9	10.6	0.14		10.27	0.08	0.50	196	0.18		0.90

****: $p < 0.01$; *Averages indicated by similar letter in the same column aren't statistically different from each other within P<0.05 error limit according to LSD test.**

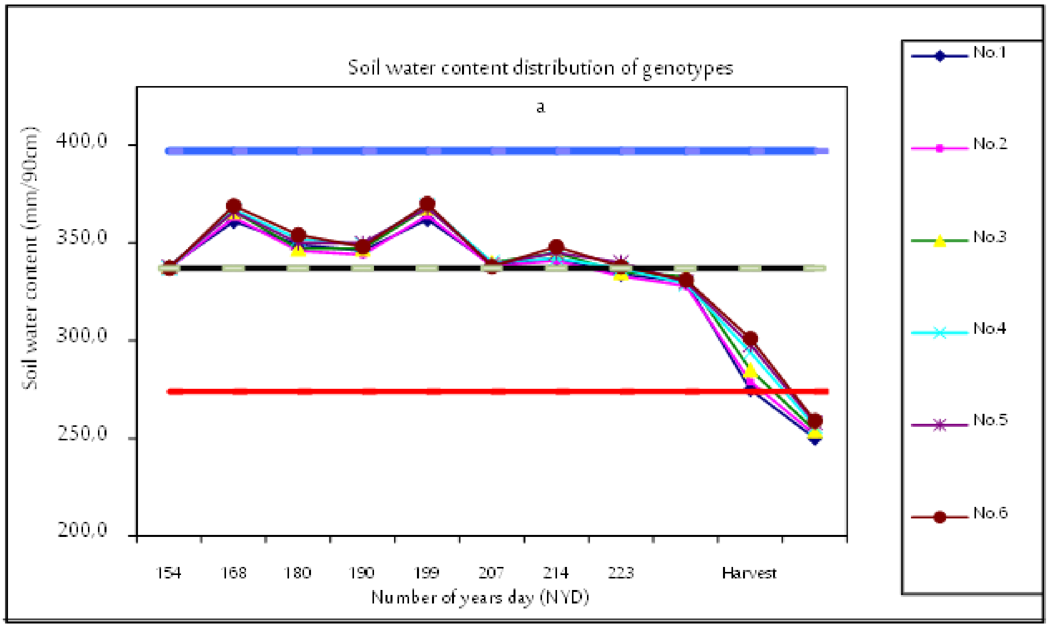

FIGURE 1. SOIL MOISTURE CONTENTS DURING GROWING PERIOD (SIIRT PROVINCE)

The correlation coefficients (r) for the relationships between soil moisture content (SMC), water use efficiency (WUE), crop water stress index (CWSI), yield, leaf area index (LAI), chlorophyll meter (CM), seasonal crop water use (ET) and total applied water (I) are presented in Table 2. As seen in the table, there are statistical relationships between all these aspects at a level of 1%. No statistically significant relationships were found between certain evaluation criteria. Following the correlation analysis, performed on the criteria evaluated during the study year, a positive correlation was determined between soil moisture and chlorophyll (58%), and ET (73%) and irrigation water (75%). As soil moisture content increased, chlorophyll content and ET increased, and as applied water increased, soil moisture tended to increase as well. However, a negative correlation was found between soil moisture content and water use efficiency and CWSI (Table 2).Assoil moisture content decreased, water use efficiency, CWSI and yield tended to increase. The no.2 genotype with the lowest soil moisture level resulted in a relatively higher yield when compared to other genotypes. This genotype was capable of availing from the existing soil moisture at an optimum level when compared to others. Camoglu et al. (2011) performed correlation analyses between leaf water content, chlorophyll meter value, yield, leaf area index, dry bio mass yield, seasonal crop water use, and the applied water, and they reported relationships with statistical significance at a level of 1%. Similarly, Kaman (2007) determined the yield reactions of five corn varieties under three different irrigation programs, and reported that there might be differences in plant size, leaf area index, dry matter yield, root density, leaf water potential, and yield parameters, depending on irrigation programs. The values mentioned by the above authors in relation to the observed parameters were different, albeit slightly, when compared to the results of the present study. Those minor differences might be associated with the genetic richness of the variety used in the trial and climate conditions in the experimental farms.

Daily CWSI was shown in Figure 2 (a), changes throughout the vegetation period was given in (b), and the lower limit (LL) equation, where no CWSI with upper limit (UL) equation, where crop is deemed to be fully under water stress was given in (2c). As shown in Figure 2c, the lower limit (LL) equation, related to the first year of the study, where there is no crop water stress, in other words, the crop is deemed to have potentially completely evapotranspiration, was defined as Tc-Ta = 1.115 - 2.357 VPD (R^2 = 0.824). In the equation, the intersection values of the LL line were defined as positive. Idso et al. (1982) reported that intersection value is never lower than 0.0, and that is caused by the fact that even when it is saturated in atmosphere and vapour pressure deficit, VPD is brought to zero, there is a positive water vapour flux from the leaf to the atmosphere. In that case, according to the LL equation, and as discussed in previous studies on this subject, it could be revealed that there was a positive water vapour flux from the leaf to the atmosphere during the whole time (Koksal, 1995; Gencel, 2009).The upper limit (UL) equation, where the crop is deemed to be fully under water stress, was defined as Tc-Ta = 1.150 + 0.068 VPG (R^2=0.765). The inclination in the UL equation was very small so it was neglected, and as such, canopy temperature and air temperature difference in UL was defined as 1.15 ºC. The CWSI values based on the varieties were mostly between 0.0 (no water stress) and 1.0 (state of maximum stress).Stress index proved to be very low during the morning hours, however it reached the maximum level (0.80) between the hours of12:^{00}and14:^{00} (Figure 2a). During the vegetation period, the highest CWSI value was determined in line no.1 as 0.44. The lowest CWSI was observed in line No.2 as 0.14. The threshold CWSI value, when the corn seed yield starts decreasing, determined by the pre-irrigation infrared thermometer observations, was defined as 0.19. At the beginning of the vegetative period, CWSI and chlorophyll values were similar for all species, but towards the end of the vegetative period and mid-generative period, they inclined to increase, while chlorophyll contents inclined to decrease. This could be a result of the fact that the majority of available water could have been used by the corn plant to grow seeding, thus, leaving less water to convey to the leaves (Figure 2b).

TABLE 2
THE CORRELATION COEFFICIENTS (R) FOR THE RELATIONS BETWEEN WUE, CWSI, CONTENT OF CHLOROPHYLL, CROP WATER USE, IRRIGATION WATER, SOIL MOISTURE CONTENT AND YIELD.

Parameters	Water use efficiency (WUE)	Crop water stress index (CWSI)	Content of chlorophyll (CM)	Crop water use (ET)	Irrigation water (mm)	Soil moisture content
Crop water stress index	0.585***					
Content of chlorophyll	-0.283NS	-0.802***				
Crop water use	-0.862***	-0.489**	0.189NS			
Irrigation water (mm)	-0.870***	-0.527***	0.232NS	0.997***		
Soil moisture content	-0.846***	-0.844***	0.580***	0.737***	0.757***	
Yield	0.742***	0.478**	-0.258NS	-0.935***	-0.944***	-0.612***

*****: $p < 0.001$, NS: Not significant.**

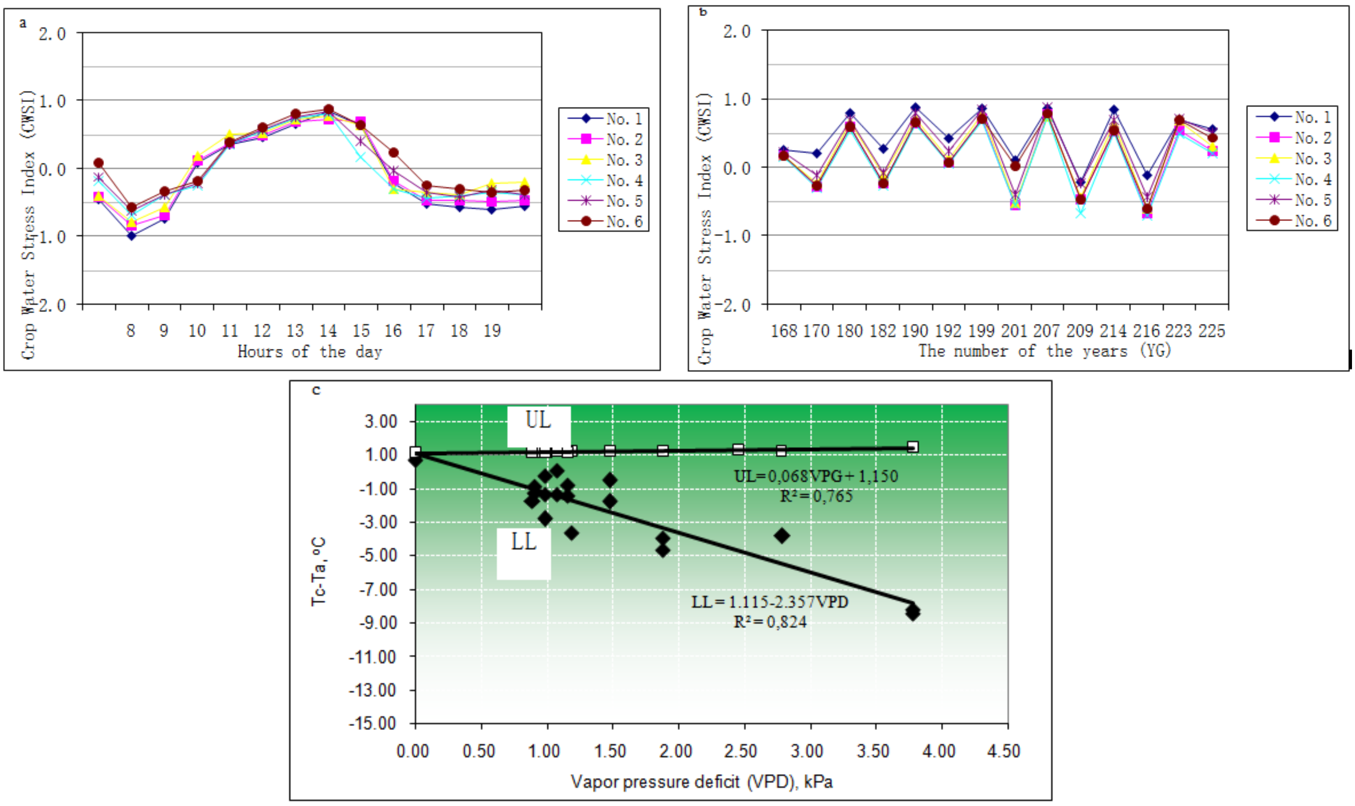

FIGURE 2. (A) CROP WATER STRESS HOURS OF THE DAY (PER HOURS), (B) WATER STRESS FOR FULL IRRIGATION, (C) CROP WATER STRESS LIMITS: LL- LOWER LIMIT AND UL- UPPER LIMIT.

In the study, it was observed that the plant height in Siirt and Sakarya locations ranged between, 232-165 and 271-244 cm, respectively, stem height varied between 43-72 and 61-63 cm; stem diameter ranged between 3.73-4.26 cm, 4.3-4.7 cm; and tasselling growth duration ranged between 48-59 and 61-63 days. Cesurer et al. (2001) stated that initial stem height ranges between 40.5-24.2 cm, plant size between 114.9-124.5cm, fresh stem yield between 7530-8267 kg ha^{-1}; Azapoglu (2013) reported that under Tokat Kazova conditions, tasselling growth duration in Vega sweet corn ranged between 48.1-51.3 days, plant size between 127.1-152.2 cm, stem length between 17.3-20.8 cm, seed grain per hectare between 5945-7215 kg; Sonmez et al. (2013) found that plant size ranged between 195-230 cm, stem length ranged between 21.9-23.8 cm, stem diameter ranged between 48-54.1 mm, tasselling growth duration ranged between 54.4-78.3 days, and yield ranged between 19340-20150 kg ha^{-1}. It was reported that, depending on ambient conditions, there would be a significant decrease in stem yield when water stress and drought condition are more severe (Berzyet al., 1997). Several authors stated that the reasons for the plant size differences in every experiment zone were temperature, moisture content, and precipitation (Turhal 2010). Turgut&Balcı (2002) under Bursa conditions found the plant size as 112-132 cm; Oktem, Oktem (2006) under Harran plain conditions as 168-207 cm; Egesel et al. (2007) under Çanakkale conditions as 179-212 cm; and reported that there were significant differences in sweet corn species in terms of plant size. Findings suggest that in longer species, the first stem height is taller, while it is shorter in smaller species and (Oktem&Oktem, 2006) are in line with our results.

Chlorophyll values in full and deficit irrigation locations were mostly between 58 and 64 spad values, however some of those values dropped to as low as 54 spad. The lowest chlorophyll value was obtained before irrigation, during a day with maximum temperature (39ºC). During the trial, chlorophyll values for corn genotypes during vegetative period in Sakarya and Siirt were 56.4 spad in no.4 line and 58.3 spad, also in no.4 line, while the highest one was 61.5 spad in no.2 line and 64.3 spad in no.2 line, respectively. In other genotypes, these values varied between the above-mentioned values. Chlorophyll values in Siirt location were found slightly lower than the chlorophyll values in Sakarya location, which could be due to the fact that evapotranspiration or temperatures during July and August in Siirt were greater by comparison to Sakarya. If the soil water content is high within the root zone depth, chlorophyll content is also high, but it shows tendency to decrease when soil water content is lower (Kırnak&Demirtas, 2002). As a result, the authors could suggest that leaf chlorophyll content might change due to factors such as plant and soil type, irrigation program, and the research site.

The leaf area index, LAI, was found as 4.41 the highest in no.6 variety and as 4.45 in no.6 line, respectively in Siirt and Sakarya locations, while the highest value of 5.06 was observed in no.2 line in Siirt region and as 5.10 in no.2 line, and as 5.17 in no.1 line in Sakarya region. Studies by Beigzadeh et al. (2013) obtained a LAI of 3.5 under full irrigation. Zohrabi et al. (2015) determined the highest LAI as3.11 for adequate irrigation conditions. Comparison of the data from the present study to those of the above mentioned authors demonstrates that the means determined in this research were superior. The possible reason might be cultivars, environmental conditions and soil productivity level with better irrigation water management.

IV. CONCLUSION

In general, deficit irrigation affected the growth and yield of sweet corn. Variety candidate no. 2 had the highest crop water consumption level under no irrigation condition with an average yield value of 7746 kg ha^{-1}. Therefore, sweet corn variety candidate no.2 which has an economic efficiency of crop water use, could avail even the slightest moisture in soil, has a low crop water consumption, and has an optimum level of grain yield by comparison to others, and has the lowest CWSI as 0.14, and it has been determined to be resistant against hot and semi-arid climate conditions. Thus, it was determined as a result of the findings of the study that with the use of no: 2 variety candidate as a parent (No.2), which was resistant to aridity and temperature stress, utilized the irrigation water with optimum efficiency, and with high chlorophyll content, an increase in yield could be attained. We found that to determine the arid and temperature resistant corn lines, soil moisture content values can also be used together with chlorophyll-meter values and crop water stress index.

ACKNOWLEDGEMENTS

The authors would like to thank Siirt University and Sakarya Corn Research Institute for their financial support and technical assistance.

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