Effect of Different Water Stress on the Yield and Yield Components of Second Crop Corn in Semiarid Climate

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ABSTRACT
The response of second crop corn (*Zea mays* L.) to different irrigation treatments in a semi arid climate was carried out in the field during the 2003 and 2004 growing season. Water stress was created at different development stages: early vegetative, vegetative, before tasseling, after tasseling, milk stage and after milk in order to determine the effect of irrigation treatments on vegetative growth, grain yield and yield components of corn. The effect of water stress at any stage of development on plant height, dry matter accumulation, kernel weight, kernel number per ear, ear length and ear diameter were studied. A rainfed (non-irrigated) treatment and 9 deficit irrigation treatments were applied to the Pioneer 3394 corn hybrid on a loam soil with 3 replications. Water stress significantly affected the corn grain yield. and yield components. The grain yield increased with irrigation water amount, and the highest average grain yield (11160 kg ha^{-1}) were obtained from the well irrigated treatment (K_1). Seasonal evapotranspiration increased with increased amounts of irrigation water applied. The highest seasonal ET (average of 650 mm) was determined at the (K_1) treatment. Water stress occurring during vegetative and tasselling stages reduced plant height. Total dry matter (DM) accumulation was accelerated after each irrigation application. Yield response factor (k_y) value of 1.02 were determined based on averages of two years. Significant linear relations were found for grain yield and seasonal evapotranspiration (ET). It is concluded that well irrigated treatment (K_1) could be used for the semiarid climatic conditions under no water shortage. In the case of more restricted irrigation, the limitation of irrigation water at the vegetative and tasselling stages should be avoided to maintain satisfactory growth.
Keywords: corn, water stress, growth stages, yield response factor (k_y), Aegean region.

INTRODUCTION

Corn (Zea mays L.) grown mostly under irrigated conditons, are a major commercial field crop in the Aegean region of Turkey. Especially corn has become a widely grown feed grain crop particularly as a second crop after wheat or barley in this region. Present corn production in Turkey is about 2.2 million tons of grain corn from 575.000 ha. The Aegean region of western Turkey produce 26 % of national corn production of the country (Anonymous, 2003). Long-term average annual precipitaton in the region is about 657 mm, with more than 89 % of it falling from October to March. Water loss by evapotanspiration is very high during the growing season. Therefore, irrigation is needed at this growing season to maintain and enchance crop growth and yield. Limited availability of irrigation water requires fundemental changes is irrigation management or urges the application of water saving methods. Generally applicable procedure is to assess the benefits of changing irrigation water management based on deficit irrigation which is the practice of deliberately under-irrigating. In order to implement deficit irrigation successfully, specific growth stages of the crops at which they can withstand water stress with no significant effect on plant growth and yield need to be well identified. Thus, it will be possible to develop optimum schedules for implementing deficit irrigation programmes (Anac et al., 1992). Water stress occuring during different growth stages may reduce final grain yield and the extent of yield reduction depends not only on the severity of the stress, but also on stage of the plant development (Claasen and Shaw, 1970). In the Texas conditions, Yazar et al. (1999) found that the highest grain yield, dry matter, kernel numbers and water use efficiency were obtained from well watered treatment in both years. Under severe water stress conditions leads to yield decrease, due to decreased vegetative growth including leaf expansion and dry matter accumulation (Pandey et al., 2000). Eck (1986) reported that water deficit during vegetative growth reduced kernel numbers but had little effect on kernel weight.

The vegetative and ripening periods are the most tolerant to water deficits. On the other hand, the flowering period is the most sensitive to water deficits that cause considerable grain yield decrease since less water became in the soil profile (Doorenbos and Kassam, 1979). Due to limited irrigation water, it is generally acceptable that deficit irrigation should be used in semiarid conditions. However, prior to explain this cultural practice, its effects on corn yield yield components and water usages should be carried out.

The purpose of this study was to evaluate the effects of water stress occurring at various growth stages of second crop corn yield and yield components. The results of this study will be provided a guideline to regional growers and irrigation agencies for water saving irrigation and optimum water management programs for second crop corn in the semiarid Aegean climate.

MATERIAL and METHODS

Field experiment of second crop corn were conducted at the Agricultural Research Station of Adnan Menderes Universty, Aydin-Turkey at 37° 51’ N latitude, 27°51’ E longitude and 56 m altitude during the 2003 and 2004 growing season. Climate in this region is semiarid with total annual precipitation of 657 mm. The climate in this region is classified as semiarid and the average values of air annual temperature, air relative humidity, wind speed, sunshine duration per day and total annual precipitation are 17.5 ^{0}C, 63 %, 1.6 m s^{-1}, 7.6 h and 657 mm, respectively (Anonymous, 2004). The soil series in the research area was Buyuk Menderes developed on aluvial meterials (Aksoy et al., 1998). The soils in the region were classified as Entisols and Fluvisols-Regosols according to soil Taxonomy (Soil Survey Staff, 1999) and FAO-UNESCO (1989), respectively. The soil type of the experimental area was loam and sandy loam in texture and the available water holding capacity within 0.90 m of the soil profile is approximately 162 mm.

Pioneer brand 3394 corn hybrid, the most popular hybrid as a second crop corn in the research area, was planted during the last week of June (DOY:178 in 2003; DOY:182 in 2004) of each experimental year. A row spacing of 0.70 m and a within-row spacing of 0.25 m were used. Corn plots were fertilized with 75 kg ha^{-1} pure N, P and K (15 15 15 composite) before sowing and additional nitrogen dose of 115 kg ha^{-1} was applied as Ammonium nitrate 33 % when the plant reached to 0.3-0.4 m in height. The experiments were set up randomised complete block design with three replications. At planting the plot sizes were 8 x 4.2 m , whereas the basic plot sizes harvested were 21.0 m^2. Closed-end furrow irrigation method was used and the amount of water applied was measured with a flow meter.

The experiment included 10 treatments in which soil water deficits were created by delaying irrigation for different combinations of growth stages. To determine the treatments, growth stages of corn such as early vegetative, vegetative, before tasseling, after tasseling, milk stage and after milk stages were taken into consideration (Doorenbos and Kassam, 1979). The irrigation treatments were based on soil water depletion replenishments. Control treatment "K_1" was designated to receive 100 % soil water depletion and irrigation was applied at each growth period with the amount of irrigation water required to fill the 0.90 m root zone to field capacity. Individual treatments were irrigated similarly except for delaying the irrigation applicaton at a given stage. The other treatments (K_8 and K_9) were the same as $K_{1,}$ but a 50 % and 25 % of water deficit were applied at a given stages for K_8 and K_9 treatments, respectively. The same application was repeated for each individual growth period. for K_8 and K_9 treatments during the total growing season.

Soil water level was monitored by using the gravimetric method from the plots of the second replication of the various tratments. The amount of soil moisture in 0.90 m depth was used to initiate irrigation and the values within 1.20 m depth were used to obtain the evapotranspiration of the crop. (Heerman, 1985);

$$ET = P + I - D \pm \Delta W$$

where P is the rainfall (mm), I is the irrigation applied to individual plots (mm), D is the deep percolation and ΔW is variation in water content of the soil profile (mm). Since the amount of irrigation water was only sufficient to bring the water deficit to field capacity, deep percolation was neglected.

In order to detemine dry matter (DM) above the ground level, all corn plants within 0,5 m of a row section in each plot were cut at ground level at 15 day intervals. Collection of corn plant samples were started one week before first irrigation and continued until harvest. Corn leaves and rest of the plants were cut into pieces and then oven dried at 65 °C to a constant weight (Yazar et al., 2002)

Corn ears was harvested by hand from 7.5 m section of the two adjacent center rows (60 plants) on 11 November 2003 (DOY:315) and on 8 November 2004 (DOY:313). Grain yields were converted to a standard grain water content of 15.5 % wet basis (Yazar et al., 1999). The harvest data were analysed for grain yield per unit area as well as 1000 kernel weight, kernel number per ear. A calculated estimate for kernel numbers per ear have been determined from data obtained from kernel and ear numbers per plot. Twenty plants were randomly selected from the each plot (at maturity period of the plants) for measurement of plant height.

The effect of water stress during growing season and individual growth stages on fruit yield was investigated using Stewart's model (Doorenbos and Kassam, 1979) as follows:

$$(1- \frac{Y_a}{Y_m}) = k_y\, (1- \frac{ET_a}{ET_m})$$

where Y_a is actual harvested yield (kg ha^{-1}), Y_m is the maximum harvested yield (kg ha^{-1}), k_y is the yield response factor, ET_a is the actual evapotranspiration (mm), ET_m is the maximum evapotranspiration (mm) corresponding to Y_m, $1-(Y_a/Y_m)$ is the relative yield decrease and $1-(ET_a/ET_m)$ is the relative evapotranspiration deficit. WUE was calculated as yield (kg ha^{-1}) divided by seasonal evapotranspiration (mm). IWUE was determined as yield (kg ha^{-1}) per unit irrigation water applied (mm) (Howell et al., 1990).

Data on effects of treatments on the yield and yield components were submitted to analysis of variance (ANOVA) . The Duncan mean separation test procedure was used to compare and rank treatments (Gomez and Gomez, 1984).

RESULT and DISCUSSION

Water Use –Yield Relationship of Corn

The length of the total growing period for control treatment (K_1) was 139 days in 2003 and 132 days in 2004, respectively. The differences in the individual growth periods between the two years may be attributed to variations in climatic factors.

The total number of irrigation, irrigation water amounts applied and seasonal water use values of corn for the experimental years are presented in Table 1. A total of six irrigations were applied to all treatments for corn during the growing season. As shown in Table 5, the amount of irrigation water applied varied from 515 to 258 mm in 2003 and from 557 to 279 mm in 2004. Water demand during the tasseling stage (before and after tasseling) was more than that of other stages. In the control treatment K_1, the amount of total irrigation water applied was 515 mm in 2003 and 557 mm in 2004 respectively. As expected the highest seasonal water use occured in the full irrigation treatment (K_1) obviously owing to an adequate soil water supply during the growing season. Therefore, K_1 treatment had the highest total water use, 612 mm in 2003 and 687 mm in 2004. Other treatments underwent water deficits and gave lower seasonal water use. The lowest water use occured in the continuous stress treatment (K_0), 170 mm in 2003; 165 mm in 2004. The seasonal water use values are consistent with the ones obtained using furrow method in Menemen region 539,6 mm by Anac et al. (1992). Under surface irrigation applications, seasonal water use of corn was obtained by Kanber et al. (1990) as 605-474 mm in Çukurova conditions.

As shown in Table 2 data obtained from the two year study showed that corn grain yield was significantly (P<0.01) affected by irrigation treatments. The grain yield ranged from 11260 to 3100 kg ha^{-1} in 2003 and from 11060 to 2600 kg ha^{-1} in 2004 for the different irrigation regimes (Table 2).

Table 1. Irrigation treatments, seasonal irrigation water applied (I) and seasonal water use (ET)

Treatments	Early vegetative	Vegetative	Before tasseling	After tasseling	Milk stage	After milk stage	I (mm)	ET (mm)
2003								
K_1	30	85	110	100	110	80	515	612
K_2	30	85	113	92	118	-	438	567
K_3	30	85	112	108	-	90	425	551
K_4	30	85	100	-	160	70	445	536
K_5	30	85	-	146	105	65	431	523
K_6	30	-	165	90	110	75	470	592
K_7	-	100	110	100	126	60	496	603
K_8	15	43	55	50	55	40	258	387
K_9	23	64	83	75	83	60	388	508
K_0	-	-	-	-	-	-	-	170
2004								
K_1	40	80	105	124	130	78	557	687
K_2	40	80	99	130	125	-	474	581
K_3	40	80	85	125	-	115	445	573
K_4	40	80	102	-	170	75	467	561
K_5	40	80	-	149	105	85	459	534
K_6	40	-	130	110	150	60	490	569
K_7	-	95	110	125	145	60	535	607
K_8	20	40	53	62	65	39	279	407
K_9	30	60	78	93	98	59	418	520
K_0	-	-	-	-	-	-	-	165

Increasing water amounts resulted in a relatively higher yield. As would be expected, the highest yield was obtained from the K_1 treatment with 100 % irrigation and the lowest fruit yield was obtained from K_0 treatment with no irrigation. The grain yield for seasonal treatments (K_8 and K_9) was reduced from 14.2 % to 36.7 % in 2003 and from 14.1 % to 37.1 % in 2004. It was observed that ratio of decreases in grain yield for each percent of deficit rate was not constant. According to individual growth period's treatments, the highest decrease was obtained from the flowering and milk stage treatments (K_4, K_5, and K_3) and this decrease ranged from 18.6% to 34.4% in both years (Table 2) Water stress imposed during the early vegetative, vegetative and after milk stages had almost similar effects on grain yield. Average yield reduction during these stages were 11.9 and 18.1 %. Results obtained from our study concerning the effect of timing of water deficit on grain yield are comparable with those published earlier (Doorenbos and Kassam, 1979; Musick and Dusek, 1980; Eck, 1984; Ogretir, 1994; Yıldırım et al., 1996). Field trials showed that corn is very sensitive to water deficits at tasseling and silking stages and is more tolerant at milk stages (Ogretir, 1994).

Table 2. The effect of irrigation treatment on grain yield (Y), water use efficiency (WUE) and irrigation water use efficiency (IWUE) for the experiment period in 2003-2004

Year	Treatments	Y (kg ha^{-1})	Relative yield decrease (%)	WUE kg m^{-3}	IWUE (kg m^{-3})
2003	K_1	11260 a**	-	1.83	1.58
	K_2	9900 c	12.0	1.74	1.55
	K_3	9160 d	18.6	1.66	1.42
	K_4	7380 f	34.4	1.37	0.96
	K_5	8670 e	23.0	1.65	1.29
	K_6	9720 c	13.6	1.64	1.40
	K_7	10750 b	4.5	1.78	1.54
	K_8	7120 f	36.7	1.83	1.55
	K_9	9660 c	14.2	1.90	1.69
	K_0	3100 g	72.4	1.82	-
2004	K_1	11060a**	-	1.61	1.51
	K_2	9750 b	11.8	1.67	1.50
	K_3	8950 c	18.6	1.56	1.42
	K_4	7250 e	34.4	1.29	0.99
	K_5	8300 d	24.9	1.55	1.24
	K_6	9550 b	13.6	1.68	1.41
	K_7	10550a	4.6	1.74	1.49
	K_8	6950 e	37.1	1.70	1.55
	K_9	9500 b	14.1	1.82	1.65
	K_0	2600 f	76.4	1.58	-

**: Mean followed by different letters (a,b) indicate statistically significant differences at the level of 1 % for Duncan's Multiple Range Test

The relationship between seasonal water use and corn grain yield have been evaluated for each experimental year (Fig 1. and Table 2.). The relationship between seasonal water use and yield was linear ($P<0.01$) for two years. The linear relation of corn grain yield to water use is in agreement with other studies for corn in the Mediterranean region (Irmak et al., 2000); in the Çukurova region (Kanber et al., 1990); in the sountheast Turkey (Yazar et al., 2002).

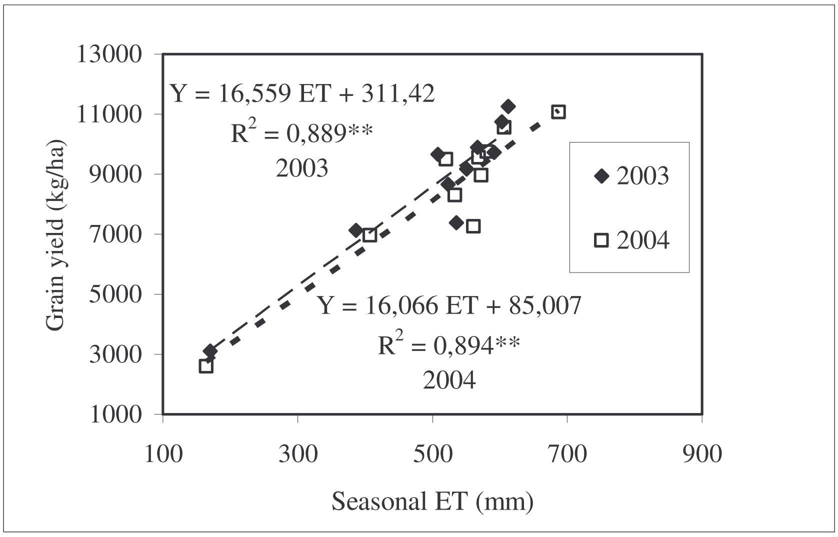

Figure 1. The relationship between grain yield and seasonal ET

Irrigation Water Use (IWUE), Water Use (WUE) Efficiencies and Yield Response Factor (k_y) for Corn

Water use and irrigation water use efficiency (WUE, IWUE) were listed in Table 2 . The WUE and IWUE were different depending upon the treatments and did not significantly change when irrigation amount increased. WUE values varied from 1.37 to 1.90 kg m^{-3} in 2003 and 1.29 to 1.82 kg m^{-3} in 2004, respectively. On the other hand, the highest WUE was obtained from K_9 treatment as1.90 kg m^{-3} in 2003 and 1.82 kg m^{-3} in 2004, respectively. However, the WUE values were lowest in K_4 treatment in both years. The WUE results are in agreement with those WUE values reported by Stone et al. (1996). The authors stated that grain yield increased with irrigation frequency and seasonal irrigation amount, and the WUE between treatments was not significantly different. WUE values of 1.83 and 1.61 kg m^{-3} from well irrigated treatment (K_1) in 2003 and 2004 are in agreement with those of 1.78-1.60 kg m^{-3} reported by Istanbulluoglu et al. (2002). The irrigation water use efficiencies (IWUE) of the treatments were lower than the water use efficiencies (WUE) in both years. This could be attributed to water used from soil stroge. IWUE values of 1.25-1.46 kg m^{-3} was obtained by Musick and Dusek, (1980) and 1.9 kg m^{-3} by Lyle and Bordovsky, (1995).

The corn yield response factor (k_y) was determined for the combined data from both years using the methods of Stewart et al. (1977). The relative yield decrease ($1-Y_a/Y_m$) increased linearly with relative evapotranspiration deficit ($1-ET_a/ET_m$). When data from both years were combined, the coefficient of determination (r^2) was 0.85; the relationship was statistically significant at the level of $P<0.01$; and the yield response factor (k_y) was 1.02. Similar relationships were obtained in other corn studies. For instance, the avarege k_y value of corn (1.02) obtained from the study is consistent with those of 0.98 determined by Kanber et al. (1990); 0.97 reported by Yıldırım et al. (1996).

Dry Matter (DM) Accumulation to Water Stress

Dry matter accumulation was significantly affected (P<0.01) by the water stress for corn. The highest dry matter of corn was obtained from K_1 treatment as 3.13 kg m^{-2} and 3.0 kg m^{-2} in 2003 and 2004, respectively (Table 3). In addition, the second highest dry matter of corn was recorded from K_7 treatment as 2.93 kg m^{-2} and 2.86 kg m^{-2} in 2003 and 2004, respectively. As could be expected, the most severe effect of water deficit on dry matter loss was observed from the non-irrigated treatments. The adverse effect of water stress on dry matter accumulation appeared under all water deficit treatments in the 2003 and 2004 experimental years. Serious decreases have been determined for corn plants exposed to water stress during the period of before and after tasseling stages (K_4 and K_5) and 50 % reduction of irrigation water amounts applied through multiple irrigation practices (K_8). Values of dry matter weight loss in those treatments were determined to vary in the ranges of 30-32, 30-27 and 29-30 % in 2003 and 2004 experimental years. Dry matter yield of 3.00-3.15 kg m^{-2} accumulated of our study under well irrigation conditions (K_1) is consistent with previous reports for second crop corn (Yazar et al., 2002). Corn dry matter accumulation and grain yield increased significantly by irrigation (Yazar et al., 1999).

Plant Height, Kernel Weight, Kernel Number per Ear, Ear Length and Ear Diameter to Water Stress

The average values of all corn yield components, namely plant height, kernel weight, kernel number per ear, ear length and ear diameter were summarized in Table 3 for the experiment period in 2003 and 2004. Statistically significant differences (P<0.01) were found between the different treatments for each year.

The development of plant height was slow from the emergence to the formation of 3-4 leaves and quite fast from this stage to the tasseling stage. Irrigation at all stages (K_1; 257.6 cm) and limited

Table 3. The effect of irrigation treatment on vegetative growth and yield components data of corn for the experiment period in 2003–2004

Year	Treatment	Plant height (cm)	Kernel weight (g/1000)	Kernel number per ear	Ear length (cm)	Ear diameter (cm)	Dry matter yields (kg/m^2)
2003	K_1	262.3a**	391.8a**	656.6 a**	22.3 a**	5.31 a**	3.13 a**
	K_2	251.0 b	382.0 ab	605.6 ab	21.6 ab	5.27 ab	2.48 a
	K_3	245.3 cd	358.1 abc	575.7 bc	19.8 de	5.06 c	2.38 bc
	K_4	242.8 de	377.1 ab	504.3 d	19.9 cde	5.16 abc	2.15 d
	K_5	241.6 e	375.1 ab	554.3 bcd	19.7 de	5.10 bc	2.30 bcd
	K_6	237.6 f	370.0 ab	580.3 bc	20.6 bcd	5.24 abc	2.40 bc
	K_7	248.6 bc	372.2 ab	592.3 abc	21.2 abc	5.20 abc	2.93 a
	K_8	234.3 g	351.8 bc	531.3 cd	19.3 e	5.05 c	2.21 cd
	K_9	248.8 b	377.6 ab	602.7 ab	20.9 abc	5.20 abc	2.46 b
	K_0	149.3 h	325.2 c	408.0 e	15.8 f	4.80 d	0.80 e

2004	K_1	253.0 a**	387.1 a**	639.3 a**	21.8 a**	5.28 a**	3.00 a**
	K_2	245.1 b	375.1 ab	591.4 ab	20.9 ab	5.23 ab	2.35 b
	K_3	238.6 d	340.1 ab	559.0 bcd	19.5 bc	5.02 cd	2.28 bc
	K_4	237.0 de	349.1 cde	499.7 d	19.4 bc	5.11 abc	2.06 d
	K_5	233.8 ef	351.1 bcd	543.3 bcd	18.7 c	5.04 bcd	2.10 cd
	K_6	230.8 fg	349.7 bcd	558.0 bcd	19.6 bc	5.16 abc	2.20 bcd
	K_7	240.5 cd	350.2 bcd	570.0 abc	20.3 abc	5.12 abc	2.86 a
	K_8	227.8 g	330.5 de	514.7 cd	19.0 c	4.96 d	2.11 cd
	K_9	243.0 bc	357.5 c	582.7 ab	19.8 bc	5.13 abc	2.35 b
	K_0	143.8 h	314.3 e	391.3 e	15.3 d	4.67 e	0.70 e

**: Mean followed by different letters (a,b) indicate statistically significant differences at the level of 1 % for Duncan's Multiple Range Test

irrigation treatments (K_2, 248cm; K_9, 245.9 cm) produced the highest plants based on averages of 2 years. The shortest plants (146.5 cm) were obtained from non-irrigated (K_0) treatment. The most effective irrigation treatments on plant height were at vegetative and tasseling stages, respectively. These results indicate that full and limited irrigation applied at different growth stages significantly increased plant height in corn. Our results were in agreement with the results reported by Anac et al., (1992) and Istanbulluoglu et al. (2002). Irrigation treatments also significantly affected kernel weight. The highest average kernel weight in the ranges of 389.4-378.5 g was obtained from (K_1) and (K_2) treatments. The fact that kernel weight of these treatments were higher even than the other treatments showed the determinative effect of water availability in soil during the period forthcoming grain filling. Lower kernel weight of K_3 treatment could be explained with fewer kernel set due to water stress at flowering stage. These results were also in agreement with Kanber et al. (1990), Ul (1990) and Yıldırım (1993).

Significant differences in kernel number per ear were observed between irrigation treatments. Water stress at tasseling stages and milk stages decreased the kernel set on the ear. Much higher average kernel reduction (21-23%) were determined when plants were exposed to water stress at tasseling stages. Harder et al. (1982) reported that water stress after post-silking period decreased corn grain yield by up to 33% and the number of kernels per plant by about 15%. Yazar et al. (1999) reported that kernel number per ear is moisture dependent and concluded that kernel number decrease is the primary effect of water deficit on corn grain yield. Irrigation tratments had significant effect on the ear length and ear diameter and their average values varied from 19 to 22 cm, 5.0 to 5.2 cm, respectively. The lowest average ear length and ear diameter were obtained from the non-irrigated treatment as 15.9 cm and 4.7 cm, respectively. The highest ear length and ear diameter were obtained in K_1 and K_2 treatments. This implies that irrigation has a great influence on ear length and ear diameter formation. On the other hand, K_3, K_4, and K_5 treatments have a lower ear length and diameter than that of others. Thus, water stress should not be applied at tasseling and milk stage to obtain higher ear length and diameter. Our results are in close agreement with those of Ul (1990), Ogretir (1994) and Istanbulluoglu et al. (2002).

CONCLUSIONS

As a result of this 2-year field study, it can be concluded that corn yield and yield components were significantly affected by water stress. Full irrigation (K_1 treatment) and 25 % of its deficits (K_9 treatment) produced the highest grain yield. Full (K_1) and deficit irrigation (K_9) at all stages produced 74.0 % and 69.5 % (as an average) higher grain yield than the non-irrigated application. A close linear relationships between seasonal evapotranspiration rate and grain yield. The obtained average k_y value of corn is 1.02 which may be used to estimate grain yield from ET according to the Stewart's model. Total dry matter (DM) accumulation was accelerated after each irrigation application. Overall, results indicate that K_1 treatment (irrigation applied at all stages) could be optimal for corn grown in semiarid regions under no water shortage. When water is limited, K_9 treatment could be used because our results showed that this had the highest WUE (1.86 kg m^{-3}) and IWUE (1.67 kg m^{-3}) based on averages of two years. On the other hand, when considering deficit irrigation by omitting growth stages, tasseling stages (before and after tasseling) of second crop corn should be given priority for irrigation followed by vegetative and milk stages. When the water stress imposed at the tasseling (before and after tasseling), the yield decrease was 29.1 % parallel with the results of irrigation water saving of 16.0 % based on averages of two years. Therefore, corn sould not be stressed in these stages given above in order to maintain satisfactory growth. It was also found that, stress conditions created at early vegetative and after milk stage did not cause significant yield decrease.

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