EFFECT OF PREVENTING IRRIGATION DURING FLOWERING AND GRAIN FILLING STAGES ON PHENOLOGICAL AND YIELD CHARACTERISTICS OF SOME EGYPTAIN MAIZE CULTIVERS

EL-Murshedy, W.A.

Agron. Dept., Fac. Agric. Cairo Univ., Giza

ABSTRACT

Effect of preventing irrigation during flowering and post- flowering stages on some phenological and yield characteristics of five Egyptian maize (*Zea mays* L.) cultivars was studied during 1999 and 2000 seasons at the Agric. Res. Stat., Fac. of Agric, Cairo Univ , .Giza, Egypt. Preventing irrigation at flowering (PIF) and grain filling (PIG) stages did not produce significant changes in number of days to 50% tasseling. Preventing irrigation at flowering caused significant elongation in the whole period from planting to physiological maturity, while preventing irrigation at post -flowering stage significantly decreased grain filling and whole growth periods. Water stress at flowering stage (PIF) caused significant reductions in all yield traits, except 100 - kernel weight which showed insignificant decrease, and barren stalks which exhibited significant increase as compared to full irrigation (FI) treatment. Preventing irrigation at grain filling (PIG) caused also significant reduction in grain yield/ plant and per faddan (4200 m^2), 100- kernel weight, ear length and harvest index, as compared to "FI". The reduction in grain yield/ faddan due to "PIF" was 40% and 38% and that due to "PIG" was 10 and 8 % in 1999 and 2000 seasons, respectively as compared to "FI". This explains the severity of water stress at flowering stage. Such stress at "PIF" is more harmful which causes greater reductions in number of ears/ plant, ear length, number of kernels/ ear, grain yield/ plant, grain yield/ fad., biological yield/ fad and harvest index, compared to water stress at "PIG". Significant differences were obtained among genotypes for all phenological traits under all irrigation treatments. Giza-2 cultivar showed the lowest absolute and relative number of days from 50% tasseling to 50% silking "TSI" under stress at flowering as compared to full irrigation. Under "FI" regime, the single cross SC10 gave the highest grain yield per plant and per faddan. Under "PIF" conditions Bashaer 13 cultivar showed the best grain yield and biological yield per faddan. Under "PIG" conditions, TWC 310 cultivar exhibited superiority over all other studied genotypes for grain yield/ fad. Such results showed that the single cross hybrid "SC 10" is less tolerant compared to both single cross hybrid Bashaer 13 and three-way

cross hybrid "TWC-310" which are more tolerant to stress conditions at flowering and green filling stages, respectively.

Key words: Maize; *Zea mays* L.; irrigation; preventing; cultivars.

INTRODUCTION

Grain yield of maize has been increased since the introduction of hybrid maize. Maize crop is known to be sensitive to available soil moisture, especially during reproductive stage. Yield decrease; resulting from soil moisture deficit; depends upon numerous factors; i. e.; growth stage at which the moisture deficit is developed, severity and duration of water deficiency, and susceptibility of examined genotype. Soil moisture deficit, during vegetative development of maize, decreases vegetative growth and affects the development of reproductive structures. It may, also, ultimately reduce grain yield (Lorens *et al.,* 1987). However, drought stresses during tasseling results in the greatest yield decrease due to large reduction in kernel number (Herrero and Johnson, 1981; Westgate and Boyer, 1985). Drought stress during the grain filling period primarily affects kernel weight and decrease the duration of grain filling which results in grain yield reduction (Jones and Simmons, 1983). Frederick *et al.* (1989) reported that water stress during flowering stage delayed silking and tasseling dates, in addition to, its effect on shortening the grain filling period. They also mentioned that the time interval between tasseling and silking was increased by drought stress in some but not all maize genotypes.

In Egypt, Khedr (1986) showed that skipping irrigation in maize significantly decreased ear diameter, grain weight /ear and grain yield/faddan, while ear length, number of rows/ear, number of grains/row, number of grains /ear and 100-grain weight were not significantly affected by such treatment. He also reported that plant and ear heights were significantly decreased, while time to 50% tasseling and to 50% silking was not significantly affected by increasing irrigation intervals. Water stress during pre- flowering stage increased leaf rolling and number of days to 50% silking and to 50% tasseling (El-Nomany *et al.*,1990; Ibrahim *et al.*, 1992; Hefni *et al.*, 1993; Kasele *et al.*, 1994 and Moursi, 1997). However, they reported that water deficit reduced ear height, ear length, plant height, ear leaf area, number of rows/ear, ear diameter, number of kernels /row, ear weight, kernel weight/ear, shelling percentage, 100-kernel weight and grain yield. El- Sayed (1998) found that flowering stage of maize is the most-sensitive stage to water stress. He also reported that the degree of effects of water stress varies according to maize genotype. EL- Sheikh (1999) concluded that synthetic maize cultivars may have a greater degree of stability under water stress conditions than the single and 3- way cross hybrids. The present study was conducted to study the influence of preventing irrigations at flowering and grain filling stages on the phenological as well as yield characteristics of five Egyptian maize cultivars.

MATERIALS AND METHODS

Two field experiments were carried out at the Agric. Res. Stat.; Fac. of Agric., Cairo Univ., Giza, Egypt; during 1999 and 2000 seasons. Five cultivars were used; viz.; two single crosses (SC 10 and Bashaer13), two three- way crosses (TWC 310 and TWC 320) and one synthetic cultivar (Giza 2).

The following irrigation treatments were imposed:

1- Full irrigation (FI), in which the first irrigation was applied 21 days after sowing and the next irrigations were applied at 12-days intervals (control).
2- Preventing irrigations at flowering stage (PIF), in which the 1st through 3rd irrigations were applied as for full irrigation, while the 4th and 5th irrigations were not given and then the next ones were applied.
3- Preventing irrigations at grain filling stage (PIG), in which the 1st through the 6th irrigation were applied and then the following irrigations were prevented till harvest.

Treatments were arranged in a split- plot design with three replications. Main plots were assigned two irrigation treatments and the sub- plots were devoted to maize cultivars. The experimental unit consisted of 6 ridges, 5 m long and 0.70 m width (21 m^2).Main plots were surrounded by wide ridge (1.5 m) to avoid leaching of water. Kernels were sown in hills spaced 30 cm. apart. Sowing date was on 20th and 27th of May in 1999 and 2000 seasons, respectively. Thinning to one plant per hill was practiced before the first irrigation. Calcium super phosphate fertilizer (15.5% P_2O_5 at the rate of 100 kg P_2O_5/faddan) was applied uniformly before sowing. Nitrogen fertilizer in the form of ammonium nitrate 33.5%, at the rate of 120 kg N / faddan, was applied in three equal doses before sowing, at first and at second irrigations. Other cultural practices were carried out as recommended in the area.

Data on number of days to 50% tasseling, 50% tasseling to50% silking interval (TSI), days from 50% silking to 50% physiological maturity (grain filling period), from planting to 50% physiological maturity (black layer maturity "when 50% of kernels at BLM stage" as outlined by Daynard, 1972), and percentage of barren plants were recorded on plants of two guarded ridges.

At harvest, plants of four inner ridges, in each plot, were harvested and weighed for estimating the biological yield, in ton / faddan. Ears of these plants were counted, weighed and then shelled. Grains of each plot were weighed to estimate grain yield/ plant in gram and per faddan in ardab (Ardab= 140 kg). The grain yield per plant and per faddan were adjusted to 15.5 % moisture content. Ear length (cm), number of kernels/ ear and 100-kernel weight (g) were determined from ten random ears. Harvest index was also calculated {(grain yield per faddan / biological yield per faddan) X 100}.

All obtained data were statistically analyzed according to the procedure outlined by Steel and Torrie (1980). Means were compared by LSD test at 5% level of significance according to Snedecor and Cochran (1967).

ESULTS AND DISCUSSION

A). Effect of irrigation treatments:

A.1. Phenological characteristics:

Irrigation treatments had significant effect on all studied phenological characteristics, except number of days to 50% tasseling in both seasons (Table 1). Preventing irrigation at flowering stage (PIF) caused significant elongation in the tasseling to silking interval (TSI) by 3.19 and 3.14 days, as compared with full irrigation treatment (FI) in1999 and 2000 seasons, respectively. Moreover, preventing irrigation at flowering stage caused a significant elongation in the whole period from planting to 50% physiological maturity. On the contrary, preventing irrigation at grain filling significantly decreased grain filling period as well as the whole growth period (Table 1).

Tasseling to silking interval (TSI) was prolonged as a result of water stress at flowering stage (PIF) by 73 and 64 %, when compared to full irrigation in 1999 and 2000 seasons, respectively. On the contrary, preventing irrigation at grain filling stage exhibited a considerable reduction in the period from 50% silking to 50% physiological maturity (grain filling period) by 24 and 27% and in the period from planting to 50% physiological maturity (whole growth period) by 9 and 10% in the first and second seasons, respectively, as compared to control. These results agree with previous ones reported by Jones and Simmons (1983), Frederick *et al.* (1989), Edmeades *et al.* (1993) and El- Sayed (1998) who reported that water stress during flowering stage delayed silking and tasseling dates in addition to its effect on shortening the grain filling period. They also mentioned that the time interval between tasseling and silking was increased

Table (1): Means of some phenological and yield characteristics of maize as affected by the three irrigation treatments in 1999 and 2000 seasons.

Irrigation treatments	Days to 50% tasseling	Days from 50% tasseling to 50% sillking	Days from 50% silking to 50% physiol. maturity	Days from planting to 50% physiol. maturity	Barren stalks (%)	No. of ears/ plant	Ear length (cm)	No. of kernels/ ear	100-kernel weight (g)	Grain yield/ plant (g)	Grain yield/ fad. (ardab)	Biological yield/ fad. (Tons)	Harvest index (%)
	1999 season												
F. I.	60.30 (100)*	4.34 (100)	47.13 (100)	111.77 (100)	2.92 (100)	1.19 (100)	23.04 (100)	612.77 (100)	37.59 (100)	170.97 (100)	23.39 (100)	8.17 (100)	40.07 (100)
P. I. F.	61.00 (101)	7.53 (173)	46.53 (99)	115.07 (103)	3.29 (113)	1.01 (85)	15.37 (67)	384.27 (63)	36.28 (97)	124.83 (73)	13.98 (60)	7.34 (90)	26.61 (66)
P. I. G.	61.10 (101)	4.80 (110)	35.67 (76)	101.56 (91)	2.94 (101)	1.16 (97)	22.25 (97)	579.44 (95)	28.83 (76)	155.44 (91)	21.08 (90)	8.86 (108)	33.37 (83)
L.S.D. at 0.05	NS	1.17	3.20	3.29	0.10	0.08	0.40	42.07	3.79	1.87	1.95	0.27	3.13
	2000 season												
F. I.	60.63 (100)	4.93 (100)	46.80 (100)	112.36 (100)	1.89 (100)	1.23 (100)	23.85 (100)	607.44 (100)	37.36 (100)	182.23 (100)	24.55 (100)	8.32 (100)	41.35 (100)
P. I. F.	61.67 (102)	8.07 (164)	47.00 (100)	116.73 (104)	2.38 (126)	1.04 (85)	15.12 (63)	368.88 (61)	36.54 (98)	133.19 (73)	15.26 (62)	7.61 (91)	28.06 (68)
P. I. G.	61.53 (101)	5.27 (107)	34.27 (73)	101.07 (90)	1.95 (103)	1.21 (98)	23.39 (98)	584.97 (96)	28.82 (77)	166.65 (91)	22.50 (92)	8.84 (106)	35.70 (86)
L.S.D. at 0.05	NS	1.29	1.60	2.29	0.12	0.10	0.22	55.77	1.87	1.40	2.06	0.15	3.61

F. I. = Full irrigation, P. I. F. = Preventing two irrigations at flowering, P. I. G. = Preventing two irrigations at grain filling

* Values followed means and between parentheses are relative estimates (%) to the control (full- irrigation treatment).

mentioned that the time interval between tasseling and silking was increased by drought stress in some but not all maize genotypes. While, El-Nomany *et al*.,1992; Ibrahim *et al*,.1992; Hefni *et al*.,1993; Kasele *et al*.,1994 and Moursi (1997) who demonstrated that drought stress in pre-flowering phase can markedly delay flowering in maize.

A.2. Yield and yield components:

The results presented in Table (1) show significant effects of preventing irrigation at flowering and post- flowering stages on all studied yield characteristics in both seasons.

Preventing irrigation at flowering stage (PIF) caused significant reductions in all yield traits, except 100-kernel weight which showed insignificant decrease and barren stalks which exhibited significant increase by water stress at flowering, as compared to full irrigation treatment in both seasons (Table 1). Maximum reduction due to water stress at flowering stage as compared to full irrigation was shown by grain yield/ fad which reached 40 and 38%, followed by number of kernels/ ear (37 and 39%), ear length (33 and 37 %) and harvest index (34 and 32 %), in 1999 and 2000 seasons, respectively. Minimum reduction due to preventing irrigation at flowering stage as compared to full irrigation treatment was achieved by 100- kernel weight which was 3 and 2% followed by biological yield/ fad. which was 10 and 9% in the 1st and 2nd seasons, respectively. On the contrary, barren stalks percentage increased when drought was imposed at flowering stage by 13 and 26% as compared to full irrigation in 1999 and 2000 seasons, respectively.

Water stress at grain filling stage (PIG) caused also significant reduction in grain yield/ plant and per fad, 100- kernel weight, ear length and harvest index, as compared to control in both seasons (Table 1). Maximum reduction due to water stress at grain filling was exhibited by 100-kernel weight, where it reached 24 and 23%, while minimum significant reduction was shown by number of ears/ plant which was 3 and 2% in 1999 and 2000 seasons, respectively. On the other hand, biological yield/ fad increased significantly by 8 and 6% when drought was imposed at grain filling stage as compared to full irrigation in the first and second seasons, respectively.

The highest values of all yield characteristics except, barren stalks percentage and biological yield/ fad, were obtained from the full irrigation treatment in both seasons (Table 1). The lowest percentage of barren stalks was achieved from full irrigation treatment followed by water stress treatment at grain filling, however the highest percentage of barren stalks was resulted when irrigation was prevented at flowering stage in both seasons (Table 1).

The reduction in grain yield/ faddan due to preventing irrigation at flowering stage was 40% and 38% and that due to preventing irrigation at grain filling stage was 10 and 8% in 1999 and 2000 seasons, respectively as compared to full irrigation. This explains the severity of water stress effect at flowering stage.

It is worthy to note that preventing irrigation at flowering is relatively harmful such treatment caused greater reductions in number of ears/ plant, ear length, number of kernels/ ear, grain yield/ plant, grain yield/ fad, biological yield/ fad. and harvest index compared with lower reductions obtained when irrigation was prevented at grain filling stage (Table 1). These results generally agree with several reports which indicate that maize is sensitive to moisture stress especially during the period extending from one week before silking to two weeks after silking (Claassen and Shaw, 1970 and EL- Sayed, 1998). However, in the present study; preventing irrigation at grain filling stage had much greater reduction effect on 100-kernel weight than preventing irrigation at flowering stage. Yield loss could mainly be attributed to the harmful effect of moisture stress on silk and pollen of maize during flowering stage and on dry matter accumulation in maize kernels during grain filling stage (Claassen and Shaw, 1970; Jones and Simmons, 1983 and Westgate and Boyer, 1985). These results generally agree with those of several investigators; such as; Lorens *et al.*, 1987; Grzesiak,1991; Nesmith, 1991; Ibrahim *et al.*, 1992; Hefni *et al.*, 1993; Kasele *et al.*, 1994; Moursi, 1997; EL- Sayed, 1998; and EL- Sheikh, 1999.

B). Effect of cultivars:

B.1. Phenological characteristics:

Maize cultivars had a significant effect on all phenological characteristics in both seasons, except number of days from 50 % tasseling to 50% silking in the first season (Table 2). Giza 2 cultivar was earlier than hybrids at all phenological stages in both seasons. Number of days to 50 % tasseling and number of days to from 50 % tasseling to 50 % silking were greater for Bashaer 13 than other cultivars in both seasons. SC 10 hybrid prolonged grain filling period (50% silking to 50% physiological maturity) and whole growth period (planting to 50% physiological maturity) followed by TWC 310 hybrid in both seasons. These results are in agreement with those reported by El-Batal *et al.* (1999) who found that number of days from sowing to phenological stages of maize significantly varied between genotypes.

Table (2): Means of some phenological and yield characteristics of some maize cultivars in 1999 and 2000 seasons.

Cultivars	Days to 50% Tasseling	Days from 50% tasseling to 50% sillking	Days from 50% silking to 50% physiol. maturity	Days from planting to 50% physiol. maturity	Barren stalks (%)	No. of ears/ plant	Ear length (cm)	No. of kernels/ ear	100-kernel weight (g)	Grain yield/ plant (g)	Grain yield/ fad. (ardab)	Biological yield/ fad. (Tons)	Harvest index (%)
	1999 season												
S.C. 10	61.33	5.22	46.89	113.44	3.00	1.19	21.04	550.38	34.28	164.81	20.32	8.30	34.07
Bashear 13	61.78	6.11	43.00	110.89	3.06	1.09	19.43	510.18	34.30	146.10	19.82	8.52	32.49
T.W.C. 310	60.67	5.22	46.11	112.00	3.02	1.16	21.08	531.18	33.77	158.20	19.60	7.85	34.70
T.W.C. 320	61.56	6.00	41.89	109.45	3.04	1.13	20.45	568.51	35.08	149.45	20.16	8.25	34.05
Giza 2	58.67	5.22	37.67	101.56	3.14	1.04	19.11	467.22	33.75	133.50	17.52	7.70	31.46
L.S.D. at 0.05	1.08	NS	1.74	2.35	0.05	0.03	0.52	42.07	NS	3.95	0.77	0.22	1.53
	2000 season												
S.C. 10	61.77	5.67	46.11	113.54	1.97	1.24	21.46	548.73	33.75	176.31	21.64	8.43	35.67
Bashear 13	62.21	6.78	42.89	111.87	2.04	1.14	19.75	522.73	34.41	158.07	20.89	8.64	33.79
T.W.C. 310	61.10	6.00	45.44	112.55	2.01	1.18	21.62	522.73	34.55	167.27	21.05	8.09	36.12
T.W.C. 320	62.10	6.56	41.56	110.21	2.03	1.17	21.49	545.71	35.30	160.37	21.46	8.40	35.61
Giza 2	59.21	5.44	37.44	102.10	2.32	1.07	19.60	462.24	33.20	141.43	18.82	7.72	33.99
L.S.D. at 0.05	1.03	0.90	1.17	1.94	0.03	0.07	0.41	NS	NS	3.55	0.42	0.12	0.43

B.2. Yield and yield components:

Data in Table 2 reveal that differences between maize cultivars were significant in all studied yield and yield components in both seasons, except number of kernels/ ear in second season and 100- kernel weight in both seasons. SC 10 surpassed all other studied cultivars for number of ears/ plant, grain yield/ plant and per faddan in both seasons, this may be due to the prolonged grain filling period, and lowest barren stalks percentage in both seasons (Table 2). On the other hand, the lowest values of yield characteristics were recorded for Giza 2 cultivar in both seasons. Hybrids under study outyielded Giza 2 cultivar in grain yield, yield components and biological yield in both seasons, as well as harvest index in the first season (Table 2). These results are in general agreement with those of Mourad *et al.*(1986) and Mohamed and Shams (1991) who reported that hybrid cultivars produced more grains/ ear, more grains/ plant, more ears/ plant and higher grain yield/ fad. than open- pollinated populations.

C). Effect of interaction:

Data presented herein point to the significant interaction only.

C.1. Phenological characteristics:

Data presented in Tables (3 and 4) indicated that the interaction effect between irrigation treatments and cultivars were significant for all phenological stages in both seasons, except number of days to 50% tasseling in both seasons and number of days from planting to 50% physiological maturity in the first seasons. The synthetic cultivar Giza 2 had the shortest periods for all studied phenological traits as compared to other cultivars under all irrigation treatments in both seasons. On the other hand, the single cross SC 10 showed the longest periods from 50% silking to 50% physiological maturity (grain filling period) and from planting to physiological maturity under all irrigation regimes. Moreover, Bashaer 13 cultivar the longest TSI period under water stress at flowering stage in both seasons.

It is worthy to note that Giza- 2 cultivar showed the lowest absolute number of days from 50% tasseling to 50% silking under stress at flowering (6.7 days) coupled with the lowest increase (64%) in relative value to control in 1999 season. This suggests that Giza- 2 is the most tolerant genotype in this study, with respect to TSI trait. On the contrary, for the same (TSI) trait, the single cross SC 10 could be regarded as the most sensitive, considering both absolute and relative values. These results are in general agreement with those of Frederick *et al.* (1989) and EL- Sayed (1998) who reported that the increase in TSI period due to water deficit varied among maize genotypes.

Table (3): Means of some phenological and yield characteristics of maize as affected by the interaction between irrigation regime and cultivars in 1999 season.

Irrigation treatment	Cultivars	Days from50% tasseling to 50% silk	Days from 50% silk to 50% physiol. maturity	No. of ears/ plant	Ear length (cm)	No. of kernels/ ear	100- kernel weight (g)	Grain yield/ plant (g)	Grain yield/ fad. (ardab)	Harvest index (%)
F. I.	S. C. 10	4.07 (100)	51.33 (100)	1.26 (100)	24.61 (100)	629.47 (100)	36.73 (100)	188.67 (100)	24.63 (100)	40.41 (100)
	Bashaer 13	4.74 (100)	47.33 (100)	1.16 (100)	21.69 (100)	608.13 (100)	37.97 (100)	165.90 (100)	23.34 (100)	37.94 (100)
	T.W.C.310	4.07 (100)	51.00 (100)	1.23 (100)	24.24 (100)	608.27 (100)	36.41 (100)	179.53 (100)	23.26 (100)	40.80 (100)
	T.W.C.320	4.74 (100)	46.00 (100)	1.21 (100)	22.92 (100)	678.27 (100)	38.89 (100)	171.84 (100)	24.49 (100)	41.75 (100)
	Giza 2	4.07 (100)	40.00 (100)	1.09 (100)	21.73 (100)	539.73 (100)	37.95 (100)	148.39 (100)	21.21 (100)	39.45 (100)
P. I. F.	S.C. 10	7.00 (171)	50.67 (99)	1.07 (84)	15.79 (64)	416.93 (66)	36.16 (98)	136.33 (72)	14.85 (60)	28.01 (69)
	Bashaer 13	8.67 (183)	46.00 (97)	0.99 (85)	15.06 (69)	368.00 (61)	36.35 (96)	121.39 (73)	15.69 (67)	28.23 (74)
	T.W.C.310	7.00 (172)	49.33 (97)	1.04 (85)	15.96 (66)	395.87 (65)	34.21 (94)	131.05 (73)	13.59 (58)	26.77 (66)
	T.W.C.320	8.33 (176)	45.33 (98)	1.01 (83)	15.71 (69)	392.93 (58)	38.26 (98)	122.22 (71)	14.15 (58)	26.70 (64)
	Giza 2	6.67 (164)	41.33 (103)	0.95 (87)	14.35 (66)	347.60 (64)	36.42 (96)	113.15 (76)	11.64 (55)	23.35 (59)
P. I. G.	S.C. 10	4.60 (113)	38.67 (75)	1.23 (98)	22.73 (92)	604.73 (96)	29.95 (82)	169.41 (90)	21.48 (87)	33.78 (84)
	Bashaer 13	4.93 (104)	35.67 (75)	1.13 (97)	21.54 (99)	554.40 (91)	28.58 (75)	151.00 (91)	20.43 (88)	31.30 (82)
	T.W.C.310	4.60 (113)	38.00 (74)	1.20 (98)	23.03 (95)	589.40 (97)	30.67 (84)	164.02 (91)	21.96 (94)	36.51 (89)
	T.W.C.320	4.93 (104)	34.33 (74)	1.16 (96)	22.72 (99)	634.33 (94)	28.09 (72)	154.29 (90)	21.83 (89)	33.70 (81)
	Giza 2	4.93 (121)	31.67 (79)	1.07 (98)	21.25 (98)	514.33 (95)	26.88 (71)	138.47 (93)	19.71 (93)	31.57 (80)
LSD at 0.05		0.77	1.38	0.05	0.63	23.76	2.50	2.26	1.33	1.66

* Values followed means and between parentheses are relative estimates (%) to the control (full- irrigation treatment).

Table (4): Means of some phenological and yield characteristics of maize as affected by the interaction between irrigation regime and cultivars in 2000 season.

Irrigation treatment	Cultivars	Days from50% tasseling to 50% silking	Days from50% silk. to 50% physiol. maturity	Days from planting to 50% physiol. maturity	Barren stalks (%)	No. of ears/ plant	Ear length (cm)	100- kernel weight (g)	Grain yield/ plant (g)	Grain yield/ fad. (ardab)	Biologi. Yield/ fad. (Tons)	Harvest index (%)
F.I.	S. C. 10	4.67 (100)	50.67 (100)	116.17 (100)	1.79 (100)	1.32 (100)	25.42 (100)	36.65 (100)	201.03 (100)	25.93 (100)	8.77 (100)	41.39 (100)
	Bashaer 13	5.67 (100)	47.33 (100)	114.50 (100)	1.84 (100)	1.20 (100)	22.57 (100)	38.01 (100)	177.65 (100)	23.96 (100)	8.59 (100)	39.03 (100)
	T.W.C.310	5.00 (100)	49.67 (100)	115.17 (100)	1.80 (100)	1.27 (100)	24.45 (100)	36.53 (100)	191.29 (100)	24.57 (100)	8.22 (100)	41.85 (100)
	T.W.C.320	5.00 (100)	46.00 (100)	112.83 (100)	1.83 (100)	1.24 (100)	24.41 (100)	38.79 (100)	182.29 (100)	25.76 (100)	8.35 (100)	43.23 (100)
	Giza 2	4.33 (100)	40.33 (100)	103.16 (100)	2.20 (100)	1.13 (100)	22.41 (100)	36.82 (100)	158.89 (100)	22.54 (100)	7.67 (100)	41.23 (100)
P. I. F.	S.C. 10	7.33 (157)	50.33 (99)	120.33 (104)	2.27 (127)	1.09 (83)	15.40 (61)	35.22 (96)	142.37 (71)	15.91 (61)	7.49 (85)	29.75 (72)
	Bashaer 13	9.33 (165)	47.00 (99)	119.33 (104)	2.39 (130)	1.04 (87)	14.17 (63)	36.74 (97)	132.74 (75)	16.96 (71)	8.10 (94)	29.31 (75)
	T.W.C.310	8.00 (160)	50.00 (101)	119.33 (104)	2.35 (131)	1.06 (83)	15.92 (65)	36.24 (99)	136.68 (71)	15.01 (61)	7.36 (90)	28.53 (68)
	T.W.C.320	9.00 (180)	45.67 (99)	116.67 (103)	2.38 (130)	1.06 (85)	15.84 (65)	38.58 (99)	133.34 (73)	15.47 (60)	7.71 (92)	28.12 (65)
	Giza 2	6.67 (154)	42.00 (104)	108.00 (105)	2.50 (140)	0.99 (88)	14.27 (64)	35.94 (98)	120.83 (76)	12.94 (57)	7.37 (96)	24.61 (60)
P. I. G.	S.C. 10	5.00 (107)	37.33 (74)	104.13 (90)	1.85 (101)	1.30 (98)	23.56 (93)	29.37 (80)	185.54 (92)	23.10 (89)	9.02 (103)	35.86 (87)
	Bashaer 13	5.33 (94)	34.33 (73)	101.79 (89)	1.89 (103)	1.19 (99)	22.53 (100)	28.48 (75)	163.82 (92)	21.75 (91)	9.22 (107)	33.04 (85)
	T.W.C.310	5.00 (100)	36.67 (74)	103.14 (90)	1.87 (104)	1.23 (97)	24.50 (100)	30.89 (85)	173.86 (91)	23.56 (96)	8.68 (106)	37.99 (91)
	T.W.C.320	5.67 (113)	33.00 (72)	101.14 (90)	1.89 (103)	1.22 (98)	24.21 (99)	28.52 (73)	165.47 (91)	23.15 (90)	9.13 (109)	35.47 (82)
	Giza 2	5.33 (123)	30.00 (74)	95.13 (92)	2.27 (103)	1.10 (97)	22.13 (99)	26.84 (73)	144.56 (91)	20.96 (93)	8.13 (106)	36.15 (88)
LSD at 0.05		0.97	0.89	1.80	0.05	0.09	0.39	1.60	1.80	1.07	0.17	2.08

* Values followed means and between parentheses are relative estimates (%) to the control (full- irrigation treatment).

C.2. Yield characteristics:

Data presented in (Tables 3 and 4) indicated that the interaction effect between irrigation treatments and cultivars were significant for all yield components in both seasons, except barren stalks (%) and biological yield in 1999 season and number of kernels/ ear in 2000 season.

Under full irrigation regime, the single cross SC10 gave the lowest barren stalks percentage, and the highest grain yield per plant and per faddan, ears/ plant and ear length in both seasons and the highest kernels/ ear in 2000 season. On the contrary, Giza- 2 showed under full irrigation treatment the lowest values for yield and yield components and the highest percentage of barren stalks in both seasons (Tables 3 and 4).

Under water stress at flowering stage Bashaer 13 cultivar showed the best grain yield and biological yield per faddan in both seasons for both absolute and relative values. Therefore this cultivar could be regarded as the most tolerant under stress at flowering. With respect of grain yield/ plant and ears/ plant in both seasons under water stress at flowering, the SC 10 cultivar exhibited the best estimates. Giza- 2 recorded the lowest values for most yield characteristics and the highest values of barren stalks percentage in both seasons under stress at flowering.

Comparing cultivars under water stress at grain filling stage, the three- way cross TWC 310 exhibited superiority over all other studied genotypes for grain yield/ fad, harvest index, 100-kernel weight and ear length in both seasons. Thus, this hybrid could be regarded as the most tolerant under water stress conditions at post-flowering stage. Moreover, the single cross SC 10 showed superiority under stress conditions at the same stage (grain filling) for grain yield/ plant and number of ears/ plant in both seasons.

Considering grain yield per faddan as the final product of all yield components, the present results showed that the single cross hybrid "SC 10" is less tolerant compared to both single cross hybrid Bashaer 13 and three-way cross hybrid "TWC-310" which are more tolerant to stress conditions at flowering and grain filling stages, respectively. This illustrates the differential response of the same group of genotypes under different water stress conditions.

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الملخص العربى

تأثير منع الري خلال التزهير وامتلاء الحبوب علي الصفات الفنيولوجية والمحصول لبعض أصناف الذرة الشامية المصرية

وجيه عبد العظيم المرشدي

قسم المحاصيل – كلية الزراعة – جامعة القاهرة – الجيزة

تمت دراسة تأثير منع الري خلال مرحلة التزهير وامتلاء الحبوب علي الصفات الفنيولوجية والمحصول لخمسة أصناف من الذرة المصرية خلال موسمي ١٩٩٩ ، ٢٠٠٠ في محطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة القاهرة .

منع الرى خلال مرحلة التزهير أدى إلى إطالة الفترة من ٥٠ % طرد للنورة المذكرة حتى ٥٠ % ظهورا للحريرة كما أدى إلى زيادة الفترة من الزراعة حتى النضج الفسيولوجى زيادة معنوية فى حين أن منع الرى خلال مرحلة امتلاء الحبوب قد أدى إلى تقصير كل من فترة امتلاء الحبوب وكذلك مرحلة النمو الكلية.

أثر الإجهاد المائي عند مرحلة التزهير معنويا بالنقص على كل صفات المحصول ما عدا وزن الحبوب (وزن الـ ١٠٠ حبة) كان النقص غير معنوي بينما زادت النباتات غير الحامله للكيزان معنويا بالمقارنة بمعاملة الرى الكامل (الكنترول) .

قلل منع الرى خلال مرحلة امتلاء الحبوب معنويا كل من محصول الحبوب للنبات والفدان ووزن الـ ١٠٠ حبة وطول الكوز ودليل الحصاد بالمقارنة بمعاملة الرى الكامل حيث وصل النقص فى محصول الحبوب للفدان – الراجع إلى الإجهاد المائي أثناء مرحلة التزهير – إلى ٤٠ ، ٣٨ % فى حين وصل النقص في محصول حبوب الفدان – الراجع للإجهاد المائي خلال امتلاء الحبوب – ١٠ ، ٨ % فى موسمى ١٩٩٩ ، ٢٠٠٠ على الترتيب بالمقارنة بمعاملة الرى الكامل وهذا يوضح شدة الإجهاد المائي أثناء مرحلة التزهير .

كان الإجهاد خلال مرحلة التزهير أكثر ضرراً حيث قلل كثيراً من عدد الكيزان علي النبات وطول الكوز وعدد الحبوب في الكوز ومحصول الحبوب للنبات ومحصول الحبوب للفدان والمحصول البيولوجي للفدان ودليل الحصاد وذلك بالمقارنة بالإجهاد المائي خلال مرحلة امتلاء الحبوب . لوحظ أن هناك اختلافات معنوية بين التراكيب الوراثية في جميع المراحل الفينولوجية تحت معاملات الري المختلفة حيث كان الصنف جيزة ٢ أقل نسبياً في عدد الأيام من ٥٠ % طرداً للنورة المذكرة حتى ٥٠ % ظهوراً للحريرة تحت الإجهاد المائي أثناء مرحلة التزهير بالمقارنة بالري الكامل .

أعطى الصنف هجين فردي ١٠ تحت نظام الري الكامل أعلـــي محصـــول حبوب للنبات والفدان بينما كان الصنف الهجين الفردي بشا ير ١٣ أحسن الأصناف في محصول الحبوب والمحصول البيولوجي للفدان تحت الإجـــهاد المـــائي خـــلال مرحلة التزهير أما الصنف هجين ثلاثي ٣١٠ فقد تفوق على باقى الأصنـــاف فـــي محصول الحبوب / الفدان تحت الإجهاد المائي خلال مرحلـــة امتـــلاء الحبـــوب . وعليه فإنه يمكن القول إعتماداً على نتائج هذا البحث – وتحت الظروف المماثلـــة – إن الهجين الفردى ١٠ لا يتحمل الإجهاد المائى خلال مرحلتى التزهـــير وامتـــلاء الحبوب فى حين أظهر الهجين الفردى بشاير ١٣ تحملاً للإجهاد المائى أثناء مرحلة التزهير أما الهجين الثلاثى فقد كان أكثر تحملاً للإجهاد المائى أثناء مرحلة امتـــلاء الحبوب .