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MAIZE YIELD AND WATER RELATIONS UNDER DIFFERENT IRRIGATION AND PLNAT DENSITY TREATMENTS

Abdel-Maksoud, H.H.; M.R.K. Ashry and K.M.R. Youssef
Soil, Water and Environment Res., Inst. A.R.C., Egypt.

ABSTRACT

Field experiment was conducted at Tameia Res. Station, Fayoum Governorate during 2006 and 2007 seasons Three irrigation intervals, i.e. irrigation every I_1: 7 days, I_2: 14 days and I_3: 21 days were combined with three plant densities, i.e. D_1: 20000, D_2: 25000 and D_3: 30000 plants/fed in a split-plot design with four replications.

The main results obtained were as follows:

1. Grain yield/fed, yield components were significantly affected by irrigation intervals, plant densities and their interactions in both seasons.
2. Irrigation every 7 days and 20000 plant/fed gave the highest averages of stem diameter, ear length, ear diameter, grain weight/plant and 100-grain weight in both seasons. Nevertheless, planting maize at 30000 plant/fed and irrigation every 21 days gave the lowest yield component averages in both seasons.
3. The highest grain yield, i.e. 2742 and 2702 kg grains/fed in 2006 and 2007 seasons, respectively, were detected from irrigation every 14 days and 30000 plant/fed. On the contrary, irrigation every 21 days and 20000 plants/fed gave the lowest grain yield/fed. i.e. 2285 and 2298 kg in 2006 and 2007 seasons, respectively.
4. Seasonal consumptive use (Etc) averaged 61.92 and 62.76 cm in 2006 and 2007 seasons, respectively. The highest Etc values, i.e. 67.96 and 68.87 cm were recorded in 2006 and 2007 seasons, respectively, which obtained from irrigation every 7 days and 30000 plants/fed. Whereas, the lowest values, i.e. 56.45 and 57.13 cm in the two successive seasons, resulted from irrigation every 21 days and 20000 plants/fed.
5. The daily Etc rates were low during June, and tended to increase during July to reach its peak during August and then declined during September and October in both seasons. Based on values of ETo estimated using Penman – Monteith method and Etc values, the crop coefficient (Kc) values, for the highest grain yield produced under the treatment (I_2D_3), were 0.53, 0.74, 0.99, 0.71 and 0.62 for June, July, August, September and October, respectively.
6. The highest water use efficiency, i.e. 1.009 and 0.986 kg grain/m^3 water consumed in 2006 and 2007 seasons, respectively, were obtained under the combination of irrigation every 14 days and plant density of 30000 plants/fed.

Keywords: maize yield, yield components, irrigation intervals, plant density, water relations.

INTRODUCTION

Maize *(Zea mays L.)* is one of the most important cereal summer crops in Egypt and great efforts has been focused on increasing the productivity of such crop. Irrigation and plant density are two of principle factors those play a great role in maize production. Determining the effect of water management on crop development and yield in different environments is a very important concern in irrigation planning and maximizing grain yield. Maize is responsive crop to irrigation management, so, the vegetative growth and grain yield and its components are highly affected due to the soil moisture status . Many literatures has been cited indicating that extending the irrigation interval, in irrigating maize crop, resulted in reductions in vegetative growth traits i.e. plant height , stem diameter, ear length and ear diameter…etc . The grain yield and its components e.g. 100-seed weight, ear weight grain and weight/plant were also adversely affected (EL-Noemani *et al*. 1990, Mahrous 1991, Ibrahim *et al*. 1992 and Atta-Allah 1996). On the other hand, shortening the irrigation interval, i.e. frequent irrigation, seemed to induce higher figures of the abovementioned vegetative growth traits and grain yield and its components traits (EL-Yamani 1987, Gohar 1995 and Ashoub *et al*. 1996).

Regarding the effect of irrigation interval on maize crop – water relationship, Attia *et al*. (1994) indicated that irrigation every 28 days gave the lowest water consumptive use values ,however, WUE was increased, comparable with irrigation every 14 days. Moreover , Ainer (1983) and Abd EL-Mottaleb (1987) concluded that seasonal water use of maize tended to reduce as available soil moisture extremely decreased before the next irrigation. In addition, Irrigation at the lower soil moisture depletion i.e. frequent irrigation gave the highest water use efficiency.

As for plant density effects on maize growth, yield and yield components, Gomaa (1985),Soliman (1986) and Matta *et al.* (1990) found that increasing plant density induced higher values for plant height trait .On the contrary, Badr *et al*. (1993) and Atta-Allah (1996) stated that increasing plant density caused reductions in plant height , stem diameter, ear length, ear diameter, ear weight and 100-grain weight, whereas grain yield was increased. Furthermore, Sharaan *et al*. (1999) concluded that increasing plant density increased maize grain yield.

Concerning maize crop - water relations as affected by plant density,, Shahin *et al*. (1994) reported that increasing plant density increased seasonal consumptive use of maize. . Furthermore, Sharaan *et al*. (1999) found that increasing plant density resulted in higher seasonal water use value, and Kc values for maize crop were 0.53, 0.78, 1.08 and 0.59 for June, July, August and September, respectively .

The present trial aimed to study the effect of irrigation intervals as 7, 14 and 21 days , plant densities of 20000, 25000 and 30000 plants/fed. and its combined on maize (single cross-10 hybrid) growth traits e.g. plant height, stem diameter, ear length and ear diameter and grain yield, and its components i.e. ear grain yield and 100- grain weight. Some crop- water relations such as water consumptive use , water use efficiency and crop coefficient were also considered.

MATERIALS AND METHODS

A field experiment was conducted at the farm of Tameia Res. Agric. Station, Fayoum governorate, during 2006 and 2007 seasons to study the effect of irrigation interval and plant density on maize yield, yield components and some crop- water relations. Three irrigation treatments, i.e. I_1: irrigation every 7 days, I_2: every 14 days and I_3: every 21 days were combined with three plant densities, i.e. D_1: 20000 plant/fed. (30 cm between hills and one plant/hill), D_2: 25000 plant/fed. (25 cm between hills and one plan/hill), D_3: 30000 plant/fed (20 cm between hills and one plant/hill) in a split-plot design with four replications. Maize hybrid namely Single Cross-10 was sown, at the rate of 12 kg/fed, on June 15th and 11th in 2006 and 2007 seasons, respectively. Harvesting was done on October 7th and 5th in the two successive seasons. The sub-plot area was 21.0 cm^2 (3m x7m). Calcium super phosphate(15.5% P_2O_5) at the rate of 200 kg/fed was added during the soil preparation. Nitrogen fertilization (ammonium nitrate 33.5% N) was applied at the rate of 105 kg N/fed in three equal doses (at planting, before the 1st and 2nd irrigation). Some of soil physical and chemical properties of the experimental field, determined according to Klute(1986) and Page *et al*. 1982), are shown in Table(1). The monthly averages of climatic factors for Fayoum region during the two growing seasons are presented in Table (2). Some of the soil -water constants of the experimental site are shown in Table(3). Irrigation treatments were started post of the second irrigation.

Table (1): Physical and chemical analysis of the experimental Field during 2006 and 2007 seasons. (average of two seasons)

A-Physical analysis:					
Sand %	**Silt %**	**Clay %**	**Texture class**	**Organic matter %**	**CaCo3%**
27.49	42.87	29.64	Clay laom	1.93	5.71

B-Chemical analysis :										
ECe dS/m	**pH 1:2.5 Extract**	**Soluble cation meq/L**				**Soluble anions meq/L**				**CEC meq/100 gm soil**
		Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**	**Cl^{-}**	**HCo_3^{-}**	**Co_3^{-2}**	**So_4-2**	
5.82	8.10	9.82	7.32	39.21	0.94	28.92	1.81	-	26.56	35.92

Table (2): The monthly averages of climatic factors for Fayoum Governorate during 2006and 2007 seasons

Month	**year**	**Temperature (c°)**			**Relative humidity (%)**	**Pan* evaporation (mm/day)**
		Max.	**Min**	**Mean**		
June	2006	36.8	20.3	28.6	51.00	7.9
	2007	38.7	21.2	29.4	50.00	8.2
July	2006	37.4	21.3	29.4	51.00	7.4
	2007	38.9	21.8	30.4	50.00	7.2
August	2006	38.3	22.1	30.2	52.00	7.1
	2007	37.8	21.7	29.7	52.00	6.5
September	2006	34.8	20.3	27.5	52.00	6.0
	2007	34.3	20.5	27.4	54.00	5.5
October	2006	32.2	19.7	25.9	56.00	4.8
	2007	33.7	19.2	26.5	53.00	4.4

*** After Fayoum meteorological station (Etsa destrict)**

Table (3): The average values of soil -water constants for the experimental site during 2006 and 2007 seasons (average of the two seasons)

Soil depth (cm)	**Field capacity (%,wt)**	**Wilting point (%,wt)**	**Soil bulk density (Kg/m^3)**	**Available soil moisture (%,wt)**
0-15	48.75	23.96	1170	24.79
15-30	40.41	20.02	1210	20.39
30-45	39.82	19.64	1380	20.18
45-60	35.28	18.22	1380	17.06

At harvesting the following data were recorded for each sub-plot :-

I. Yield and yield components.

Ten guarded plants were randomly chosen from the middle ridges of each sub-plot to determine the following parameters:

1- Plant height (cm). 2- Stem diameter (cm). 3- Ear length (cm).
4- Ear diameter (cm). 5-Grain weight /Plant (gm).
6- 100-grain weight (gm). 7- Grain yield (kg/fed).

The grain yield trait was determined from the plants of the whole sub-plot area. The data collected were subjected to statistical analysis according to Snedecor and Cochran (1980) and the means were compared at 0.05 level of significance using the L.S.D test.

II. crop water relations :

1- Seasonal consumptive use (ETc).

The crop water consumptive use (ETc) was determined via the soil samples ,taken from each sub-plot , just before and 48 hours after each irrigation , as well as at harvesting time, and the ETc between each two successive irrigations was calculated according to the following equation (Israelsen and Hansen , 1962)

$$C.U\ (ETc) = \{(\varphi 2-\varphi 1)/100\}\ Bd \times D$$

where : ETc = crop evapotranspiration , cm
$\theta 2$ = soil moisture 48 hours after irrigation, % by weight
$\theta 1$ = soil moisture just before irrigation , % by weight
Bd = soil Bulk density , g/cm^3
D = soil layer depth ,cm

2- Daily ETc rate (mm/day)/month.

Calculated from the consumptive use value of each month, divided by the number of days / month.

3- Reference evapotranspiration (ETo) in mm/day .

Was estimated using the monthly averages of Fayoum climatic data (Table, 2) using the FAO Penman-Monteith equation . (Allen *et al* , 1998) .

4 – Crop Coefficient (Kc).

The values of Kc were calculated as follows:

$$\frac{\text{Actual crop consumptive use rate/month (mm/day)}}{\text{Reference evapotranspiration rate/month mm/day.}}$$

5- Water use efficiency (W.U.E)

The WUE, as kg grains /m^3 of water consumed, was calculated for different treatments as according to **Vites** (1965):

$$WUE = \frac{\textbf{Grain yield (kg/fed.)}}{\textbf{Seasonal ETc (m}^3\textbf{/fed.)}}$$

RESUTLS AND DISCUSSION

I. Growth and grain Yield components

The results in Table (4) reveal that maize vegetative growth components, i.e. plant height, stem diameter, ear length, ear diameter were significantly affected by irrigation intervals in both seasons. The highest averages of growth yield components were resulted from irrigation every 7 days, whereas the lowest ones were obtained from irrigation every 21 days in both seasons. Increasing irrigation intervals from 7 to 21 days significantly decreased plant height, stem diameter, ear length, ear diameter by 7.83, 8.65, 3.64 and9.34% in 2006 season and by 8.54, 8.71, 3.64 and 10.65% in 2007 season, respectively. Data in Table (4) illustrate that grain yield components i.e. grain weight/plant and 100-grain weight were reduced by 4.66 and10.94% in 2006 season and by 5.45% and 11.43%, in 2007 season as irrigation interval extended from 7 to 14 and 21 , respectively. It is evident that increasing irrigation intervals from 7 to 14 or 21 days significantly decreased all of growth and yield components of maize plant. These results may be due to the high available soil moisture resulted from irrigation at short intervals i.e. 7 days interval, which in turn increased photosynthesis, cell division and vegetative growth. These results are in agreement with those reported by EL-Yamani (1987), El-Noemani *et al*. (1990), Mohrous (1991) and Ibrahim *et al.*(1992).

Data recorded in Table (4) show that the averages of maize growth yield components were differed significantly due to plant density treatments in both seasons. Increasing plant density from 20000 to 25000 plant/fed significantly decreased stem diameter, ear length, ear diameter, in 2006 season by 2.29, 2.78 and 3.04%, and by 3.06, 2.64 and 2.72% in 2007 season, respectively. The yield grain yield components , grain weight/plant and 100-grain weight, were reduced by 2.87 and 4.02% in 2006 season and by 3.44% and 3.02% in 2007 season, respectively. Furthermore , increasing plant density from 20000 to 30000 plant/fed resulted in more reduction in the growth vegetative characters reached 6.11%, 3.69 and 5.91% in 2006 season and 5.75, 3.56 and 6.30% in 2007 season .The reduction in grain yield components comprised 5.98 and 6.64%, in 2006 season and reached 4.88 and 5.21% in 2007 season, respectively. On the other hand, plant height significantly increased by increasing plant density in both seasons. It could be concluded that increasing plant density of maize significantly decreased yield components except plant height which tended to increase. Such findings may referred to the competition between plants at high density on light, water and nutrients. These results are in harmony with those found by Shahin (1985), and Ibrahim *et al. (*1992).

Results of Table (4) indicate that both maize growth and yield components were significantly affected due to the interaction between irrigation interval and plant density treatments in both seasons. It is clear that irrigation every 7 days and low plant density (20000 plant/fed.) gave the highest averages of stem diameter, ear diameter, grain weight/plant and 100-grain weight in both seasons. Whereas , the tallest plants were obtained from irrigation every 7 days and plant density of 30000 plant/fed, in the two seasons. Irrigation every 21 days and plant density of 30000 plant/fed gave the lowest averages of stem diameter, ear length, ear diameter, grain weight/plant and 100-grain weight in the two seasons. Whereas, the shortest plants were detected from irrigation at 21 days and low plant density (20000 plant/fed) in both seasons.

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II. Grain yield

The results in Table (4) show that grain yield was significantly affected by irrigation intervals in both seasons. The highest grain yield, i.e. 2569 and 2541.66 kg/fed in 2006 and 2007 seasons, respectively, were resulted from irrigation every 14 days. On the contrary, irrigation every 21 days gave the lowest averages of grain yield, i.e. 2366.33 and 2390 kg/fed in the two successive seasons, respectively, On the other hand, irrigation every 7 days significantly reduced grain yield/fed by 3.44% and 4.00% in 2006 and 2007 seasons, respectively, compared with irrigation every 14 days. It is obvious that irrigating maize at short or prolonged intervals caused significantly reduction in grain yield/fed. These results may be referred to that irrigation at short intervals cause excessive irrigation which in turn increased the vegetative growth period over reproductive period, delaying tassling and silking and delay maturity. Nevertheless, irrigation at long interval(21 days) may subjecting plants to soil moisture deficit which causing reduction in growth and yield components, which in turn decreasing grain yield. These results are consistent with those reported by Gohar (1995), Ashoub *et al.*(1996) and Atta-Allah (1996).

The results in Table (4) reveal that plant density had a significant effect on grain yield in both seasons. Increasing plant density from 20 to 25 or 30 thousands of plants/fed significantly increased grain yield in 2006 season from 2404 to 2441 and 2571 kg, and in 2007 from 2359.3 kg to 2448.3 and 2564 kg, respectively. It can concluded that grain yield significantly increased as plant density increased. Such results may be due to that at the high population the stand at harvesting was increased which may compensate the decrease in grain weight/plant and grain index under high plant density. These results are in the same line of those found by Soliman (1986), Matta *et al* (1990) , Badr *et al.* (1993) and Sharaan *et al.* (1999).

The data in Table (4) indicate that the averages of grain yield were significantly varied according to the interaction between irrigation interval and plant density treatments in both seasons. Irrigation every 14 days and planting maize at 30000 plants/fed gave the highest averages of grain yield, i.e. 2742 and 2702 kg/fed in 2006 and 2007 seasons, respectively. Nevertheless, irrigation at 21 days and planting at 20000 plants/fed produced the lowest averages of grain yield, i.e. 2285 and 2298 kg/fed in the two successive seasons.

III. Crop - water relations

1. Seasonal consumptive use (ETc)

The resulted in Table (5) show that the values of seasonal consumptive use (Etc) of maize crop, as affected by the adopted experimental treatments were 61.92 and 62.76 cm in 2006 and 2007 seasons, respectively. The highest ETc values, i.e. 65.15 and 66.38 cm in 2006 and 2007 seasons, respectively, were detected from irrigation every 7 days. Meanwhile, irrigation every 21 days gave the lowest ETc values, i.e. 58.41 and 58.95 cm in the two successive seasons. It is evident that increasing irrigation interval from 7 to 14 or 21 caused remarkable decrease in seasonal ETc. These results may be referred to the high available moisture resulted from irrigation at short intervals (every 7 days), which in turn increased both transpiration from plants and evaporation from the soil surface. These results are in the same line of those reported by Abd El-Mottaleb (1987) and Attia *et al.* (1994).

The data in Table (5) reveal that increasing maize plant density from 20000 to 250000 or 30000 plants/fed increased seasonal ETc in 2006 season from 59.41 cm to 62.06 and 64.30 cm, respectively, and in 2007 season from 60.55 to 62.70 and 65.05 cm, respectively. Such findings may due to the higher transpiration surface resulted from the dense plant population .These results are in agreement with those reported by Shahin *et al.* (1994) and Sharaan *et al.* (1999).

Regarding, the effect of interaction, data recorded in Table (5) indicate that irrigating maize, planted at 30000 plants/fed, every 7 days gave the highest ETc values, i.e. 67.96 and 68.87 cm in 2006 and 2007 seasons, respectively. While, irrigation at 21 days and plant population density of 20000 plant/fed gave the lowest ETc values which comprised 56.45 and 57.13 cm, in the two successive seasons.

Table (5): Seasonal consumptive use of Maize crop (Etc) in cm, as affected by irrigation intervals, plant density and their interaction in 2006 and 2007 seasons.

Irrigation intervals	2006				2007			
	Plant density/Fed.				Plant density/Fed.			
	20000	25000	30000	Mean	20000	25000	30000	Mean
7 days	62.39	65.11	67.96	65.15	63.93	66.34	68.87	66.38
14 days	59.38	62.60	64.64	62.20	60.60	63.08	65.22	62.96
21 days	56.45	58.48	60.30	58.41	57.13	58.67	61.06	58.95
Mean	59.41	62.06	64.30	61.92	60.55	62.70	65.05	62.76

2. Daily ETc rate (mm/day).

The data in Table (6) generally, indicate that the daily ETc rates, as a function of irrigation interval and plant population density treatments (overall mean) started with low values during June (4.22 and 4.34 mm/day), then increased during July to 5.54 and 5.53 mm/day, respectively, and reached its maximum values (7.21 and 6.83 mm/day) during August in 2006 and 2007 seasons. Thereafter, the ETc rates declined again during September (4.41 and 4.64 mm/day) to reach minimum values , i.e. 3.34 and 3.37 mm/day during October (harvesting) in the two successive seasons. These results may referred to that during June (initial growth) most of the water loss is caused by evaporation from the bare soil. Thereafter, the daily ETc rate increased as the crop cover increase because transpiration took place beside evaporation to reach the peak rates at tasseling and silking period. The Etc rate tended to decrease again during September (grain filling stage) and October (harvesting).

The results in Table (6) show that increasing irrigation interval from 7 to 14 or 21 days resulted in decreasing the ETc rate during the entire growing season in both .

Table (6): Daily water consumptive use for maize crop (mm) during 2006 and 2007 seasons as affected by irrigation interval and plant density

Treatments		2006 season					2007season				
Irrigation intervals	Plant density/Fed.	June	July	Aug	Sept	Oct.	June	July	Aug	Sept	Oct.
7 days	D1 :20000	4.17	5.49	7.42	4.44	3.39	4.50	5.50	7.04	4.76	3.56
	D2 :25000	4.25	5.78	7.70	4.68	3.55	4.42	5.72	7.37	5.02	3.72
	D3 :30000	4.33	5.93	8.33	4.74	3.71	4.58	5.95	7.64	5.22	3.84
	Mean	4.25	5.73	7.81	4.62	3.55	4.50	5.72	7.35	5.00	3.70
14 days	D1 :20000	4.17	5.42	6.80	4.20	3.18	4.18	5.35	6.64	4.44	3.50
	D2 :25000	4.17	5.71	7.29	4.44	3.29	4.42	5.65	6.84	4.57	3.62
	D3 :30000	4.25	5.78	7.56	4.68	3.50	4.34	5.80	7.24	4.76	3.67
	Mean	4.19	5.63	7.21	4.44	3.32	4.31	5.60	6.90	4.59	3.59
21 days	D1 :20000	4.25	5.05	6.32	4.01	3.13	4.26	5.12	5.97	4.18	3.39
	D2 :25000	4.17	5.27	6.66	4.20	3.18	4.26	5.27	6.18	4.31	3.45
	D3 :30000	4.25	5.49	6.87	4.32	3.18	4.18	5.50	6.57	4.51	3.50
	Mean	4.22	5.27	6.61	4.19	3.16	4.23	5.29	6.24	4.33	3.44

3. Reference evapotranspiration (ETo).

The daily ETo rates during maize growing season in 2006 and 2007 seasons are presented in Table (7). The daily ETo values (mm/day) were calculated using the FAO-penman-Monteith equation via the climatic data of Fayoum Governorate (Table, 2) from June to October in both growing seasons. The obtained results in Table (7) indicate that the daily ETo rates started with high values during June and slowly decreased during July with continuous decrease during August, September and October, in both seasons. These results can be attributed to the changes in climatic factors from month to the other. In this connection, Allen *et al.* (1998), reported that the values of ETo are depend mainly on the evaporative power of the air (temperature, humidity ,wind speed and solar radiation).

4. Crop coefficient (Kc):

The crop coefficient reflects the crop cover percentage and soil conditions on the ETo values. The Kc values, estimated from the daily ETc rates (Table, 6) and the daily ETo rates (Table, 7) during the two growing seasons. The results in Table (7) reveal that the Kc values, as a function of the interaction between irrigation interval and plant density treatments (as overall mean) were low during June(initial growth stages) which reached 0.54 and 0.53 in 2006 and 2007 seasons, respectively.

Thereafter, tended to increase to be 0.75 and 0.73 in the two successive seasons during July (vegetative growth stage) to reached its maximum values during August, i.e. 1.03 and 1.02 (tasseling and silking stage). The Kc values seem to decrease again during September to be 0.72 and 0.71 in the two successive seasons (grain filling-maturity) and reached its minimum values, i.e. 0.63 and 063 in both seasons during October (harvesting stage). Such results can be referred to the large diffusive resistance of bare soil at the initial stage, which reduced with increasing the crop cover percentage until heading and grain formation, and then tended to reduced again at maturity stage. Data in Table (7) show that increasing irrigation interval from 7 to 14 or 21 days decreased the Kc values during the growing season and this trend was true in both seasons of study. Irrigation every 7 days gave the highest Kc values, whereas, the lowest values were detected from irrigating maize every 21 days in the two growing season. Increasing plant density from 20000 to 25000 or 30000 plants/fed increased the Kc values during the entire growing season. Finlly, the Kc values under the treatment (I_2D_3) which gave the highest grain yield were 0.55, 0.74, 0.99, 0.71 and 0.62 during June, July, August, September and October, respectively (average of the two seasons).

Table (7) : Reference evapotranspiration, ETo (mm/day) and Kc values for maize crop during 2006 and 2007 seasons as affected by irrigation interval and plant density treatments

Treatments		2006 season					2007 season				
Irrigation intervals	Plant density/Fed.	June	July	August	Sept	Oct.	June	July	August	Sept.	Oct.
Reference (ETo)mm/day		7.73	7.32	6.94	6.08	5.22	8.03	7.53	6.64	6.44	5.65
7 days	D1 :20000	0.54	0.75	1.07	0.73	0.65	0.56	0.73	1.06	0.74	0.63
	D2 :25000	0.55	0.79	1.11	0.77	0.68	0.55	0.76	1.11	0.78	0.66
	D3 :30000	0.56	0.81	1.20	0.78	0.71	0.57	0.79	1.15	0.81	0.68
	Mean	0.55	0.78	1.12	0.76	0.68	0.56	0.76	1.10	0.77	0.65
14 days	D1 :20000	0.54	0.74	0.98	0.69	0.61	0.52	0.71	1.00	0.69	0.62
	D2 :25000	0.54	0.78	1.05	0.73	0.63	0.55	0.75	1.03	0.71	0.64
	D3 :30000	0.55	0.79	1.09	0.77	0.67	0.54	0.77	1.09	0.74	0.65
	Mean	0.54	0.77	1.04	0.73	0.63	0.53	0.74	1.04	0.71	0.63
21 days	D1 :20000	0.55	0.69	0.91	0.67	0.60	0.53	0.68	0.90	0.65	0.60
	D2 :25000	0.54	0.72	0.96	0.69	0.61	0.53	0.70	0.93	0.67	0.61
	D3 :30000	0.55	0.75	0.99	0.71	0.61	0.52	0.73	0.99	0.70	0.62
	Mean	0.54	0.72	0.95	0.69	0.60	0.52	0.70	0.94	0.67	0.61
Mean of Plant density											
	D1 :20000	0.54	0.72	0.98	0.69	0.62	0.53	0.70	0.98	0.69	0.61
	D2 :25000	0.54	0.76	1.04	0.73	0.64	0.54	0.73	1.02	0.72	0.63
	D3 :30000	0.55	0.78	1.09	0.75	0.66	0.54	0.76	1.07	0.75	0.65
Over all mean		0.54	0.75	1.03	0.72	0.63	0.53	0.73	1.02	0.71	0.63

5. Water Use Efficiency (WUE).

Results in Table (8) show that the mean values of WUE, as a function of different irrigation interval and plant density were 0.950 and 0.932 Kg grains/m^3 water consumed in 2006 and 2007 seasons, respectively. Irrigation every 14 days gave the highest WUE value, i.e. 0.982 kg grians/m^3 water consumed in 2006 season. Meanwhile, in 2007 season, irrigation every 21 days slightly increased WUE value, i.e. 0.964 kg grains/m^3 water consumed. On the other hand, irrigation every 7 days gave the lowest WUE values, i.e. 0.906 and 0.874 kg grains/m^3 water consumed in 2006 and 2007 seasons, respectively. It could be concluded that the maize crop seemed to use irrigation water efficiently as irrigation was practiced every 14 days more than every 7 days or 21 days intervals.. These results are in agreement with those reported by Attia *et al.* (1994) and Shahin *et al.* (1994).

Data of Table (8) indicate that the differences between the WUE due to different plant density treatments were so small to compare and varied from 2006 to 2007 season. It can be noticed that in 2006 season increasing plant density from 20000 to 30000 plants/fed slightly decreased WUE values from 0.963 to 0.953 kg grains/m^3 water consumed. The same trend was observed in 2007 season, since WUE values increased from 0.928 to 0.940 kg grains/m^3 water consumed. These results may be due to the differences between the two seasons in grain yield/fed and seasonal ETc of each plant density treatment. The data in Table (8) reveal that the highest values of WUE for maize crop were (1.009 and 0.986 kg grains/m^3 water consumed) detected from irrigation every 14 days and planting at 30000 plant/fed in 2006 and 2007 seasons, respectively. Nevertheless , irrigation every 7 days and planting at 30000 plants/fed gave the lowest WUE values, i.e. 0.880 and 0.863 kg grains/m^3 water consumed in 2006 and 2007 seasons, respectively.

On conclusion, to maximize the maize crop (grown at Fayoum region) productivity and water use efficiency as well, it is advisable to planting maize (hybrid SC10) at density of 30000 plants/fed. and irrigating at 14 – day interval .

Table (8): The average values of water use efficiency by Maize crop(kg/m^3 water consumed), as affected by irrigation intervals, plant density and their interaction in 2006 and 2007 seasons.

Irrigation intervals	2006				2007			
	Plant density/Fed.				Plant density/Fed.			
	20000	25000	30000	Mean	20000	25000	30000	Mean
7 days	0.937	0.903	0.880	0.906	0.875	0.886	0.863	0.874
14 days	0.990	0.948	1.009	0.982	0.953	0.941	0.986	0.960
21 days	0.963	0.959	0.970	0.964	0.957	0.965	0.971	0.964
Mean	0.963	0.936	0.953	0.950	0.928	0.930	0.940	0.932

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المحصول والعلاقات المائية للذرة الشامية تحت معاملات الري وكثافة النباتات

حماده حسين عبد المقصود ، محمد رجب كامل عشري و كمال ميلاد رزق يوسف
معهد بحوث الأراضي والمياه والبيئة ـ مركز البحوث الزراعية ـ جيزة ـ مصر.

أقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بطامية ـ محافظة الفيوم خلال موسمي الزراعة ٢٠٠٦، ٢٠٠٧ لدراسة تأثير فترات الري وكثافة النباتات علي محصول الذرة الشامية ومكوناته (صنف هجين فردي ١٠) وبعض العلاقات المائية للمحصول ـ تفاعلت ٣ فترات للري وهي : الري كل (I_1) ٧ أيام، (I_2) ١٤ يوم، (I_3)٢١ يوم مع ٣ كثافات نباتية وهي: D_1 ٢٠، ٢٥D_2، D_3 ٣٠ ألف نبات/ ف) في تصميم القطع المنشقة مرة واحدة في أربع مكررات

وكانت أهم النتائج المتحصل عليها كما يلي :

١- تأثر محصول الفدان ومكونات المحصول معنوياً بفترات الري وكثافة النباتات والتفاعل بينهما في كلا الموسمين.

٢- أدي الري كل ٧ أيام والزراعة بكثافة ٢٠ ألف نبات/ف للحصول علي أعلي متوسطات لقطر الساق، طول الكوز، وقطر الكوز، ووزن حبوب النبات ووزن ١٠٠ جم في كلا الموسمين. بينما أدي زراعة الذرة بكثافة ٣٠ ألف نبات/ف والري كل ٢١ يوم للحصول علي أقل متوسطات لمكونات المحصول في كلا الموسمين.

٣- نتج أعلي محصول حبوب وهو ٢٧٤٢، ٢٧٠٢ كجم/ف في ٢٠٠٦، ٢٠٠٧ علي الترتيب من الري كل ١٤ يوم والزراعة بكثافة ٣٠،٠٠٠ نبات/ف بينما الري كل ٢١ يوم والزراعة بكثافة ٢٠ ألف نبات/ف أعطت أقل محصول حبوب وهو ٢٢٨٥، ٢٢٩٨ كجم/ف في موسمي ٢٠٠٦، ٢٠٠٧ علي الترتيب.

٤- كان متوسط الاستهلاك المائي الموسمي ٦١,٩٢، ٦٢,٧٦سم في موسمي ٢٠٠٦، ٢٠٠٧ علي الترتيب وكانت أعلي قيم للاستهلاك المائي الموسمي وهي ٦٧,٩٦، ٦٨,٨٧سم في ٢٠٠٦، ٢٠٠٧ علي الترتيب قد نتجت من الري كل ٧ أيام والكثافة النباتية ٣٠ ألف نبات/ف. وكانت أقل قيم للاستهلاك المائي الموسمي ٥٦,٤٥، ٥٧,١٣سم في الموسمين المتعاقدين قد نتجت من الري كل ٢١ يوم والزراعة بكثافة نباتية ٢٠ ألف نبات/ف.

٥- كان معدل الاستهلاك المائي اليومي للمحصول منخفضاً خلال يونيه ثم ازداد خلال يوليه ليصل إلي قمة الاستهلاك خلال أغسطس ثم انخفض خلال سبتمبر واكتوبر في كلا الموسمين. وكان ثابت المحصول للمعاملة التي أعطت أعلي محصول حبوب (I_2D_3) هو ٠,٣٥، ٠,٧٤، ٠,٩٩، ٠,٧١، ٠,٦٢ خلال يونيه، يوليه، أغسطس، سبتمبر، اكتوبر علي الترتيب.

٦- نتجت أعلي كفاءة استهلاك للماء وهي ١,٠٠٩، ٠,٩٨٦ كجم حبوب/م٣ ماء مستهلك في ٢٠٠٦، ٢٠٠٧ علي الترتيب من الري كل ١٤ يوم والزراعة بكثافة ٣٠ألف نبات/ف.

Table (4): Effect of irrigation intervals, plant density and their interaction on Maize yield and yield component in 2006 and 2007 seasons.

Season		2006							2007						
Treatments															
Irrigation intervals	Plant density/ fed.	Plant height (cm)	Stem diameter (cm)	Ear length (cm)	Ear diameter (cm)	Grain weight ear(g)	100-Grain weight (g)	Grain yield kg/fed.	Plant height (cm)	Stem diameter (cm)	Ear length (cm)	Ear diameter (cm)	Grain weight ear(g)	100-grain weight (g)	Grain yield kg/fed.
7 days	D1 : 20000	212.5	2.75	19.86	6.24	94.27	33.25	2457	211.5	2.73	19.81	6.14	93.50	32.75	2352
	D2 : 25000	223.0	2.65	19.80	6.00	91.50	32.50	2471	219.0	2.62	19.76	5.98	91.00	31.75	2470
	D3 : 30000	228.5	2.60	18.90	5.96	89.25	30.25	2514	225.5	2.58	19.72	5.92	90.75	29.50	2498
Mean		221.33	2.66	19.52	6.06	91.67	32.00	2480.66	218.67	2.64	19.76	6.01	91.75	31.33	2440
14 days	D1 : 20000	206.5	2.62	19.32	5.80	92.10	31.25	2470	204.5	2.61	19.98	5.70	90.87	30.50	2428
	D2 : 25000	218.0	2.58	19.14	5.68	89.70	30.25	2495	212.0	2.54	18.64	5.60	86.77	29.75	2495
	D3 : 30000	224.0	2.45	18.90	5.52	86.90	30.00	2742	221.0	2.46	18.52	5.48	86.32	29.50	2702
Mean		216.16	2.55	19.12	5.66	89.56	30.50	2569	212.50	2.53	19.04	5.59	87.95	29.91	2541.66
21 days	D1 : 20000	202.0	2.50	20.12	5.72	90.40	29.00	2285	198.0	2.48	19.28	5.62	89.21	28.25	2298
	D2 : 25000	203.0	2.45	18.68	5.55	87.60	28.25	2357	198.0	2.43	19.11	5.40	86.40	27.25	2380
	D3 : 30000	207.0	2.35	18.46	5.24	84.20	28.25	2457	204.0	2.36	18.75	5.10	83.15	27.75	2492
Mean		204.0	2.43	19.08	5.50	87.40	28.50	2366.33	200.0	2.42	19.04	5.37	86.75	27.75	2390
Mean of Plant density:															
D1 :20000		207.0	2.62	19.76	5.92	92.25	31.60	2404	204.67	2.61	19.69	5.82	91.19	30.50	2359.33
D2 :25000		214.6	2.56	19.21	5.74	89.60	30.33	2441	209.67	2.53	19.17	5.66	88.05	29.58	2448.33
D3 :30000		219.8	2.46	19.03	5.57	86.78	29.50	2571	216.83	2.46	18.99	5.50	86.74	28.91	2564
L.S.D. at 0.05															
(I)		0.79	0.01	0.02	0.01	1.19	0.97	5.29	1.48	0.03	0.05	0.07	2.11	0.86	5.15
(D)		2.70	0.03	0.03	0.04	1.44	0.72	5.67	2.52	0.02	0.04	0.09	2.66	1.19	4.07
(I) × (D)		4.68	0.05	0.02	0.07	2.49	1.75	9.83	4.36	0.04	0.07	0.15	4.60	2.06	9.68