WATER USE AND GRAIN YIELD OF MAIZE IN RELATION TO IRRIGATION SCHEDULING AND SOWING DATES.

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ABSTRACT

Field experiments were carried out at Fayoum Agric. Res. Station (Tameia) during 2008 and 2009 seasons to study the combination effects of three sowing dates, i.e. D_1:1st June, D_2:10th June and D_3: 20th June and three irrigation scheduling treatments according to cumulative pan evaporation (C.P.E), i.e. (I_1):0.8, (I_2):1.0 and (I_3): 1.2 on yields, yield components, and some water relations of maize hybrid (TWC 310). A split- plot design with four replications was used. The main results obtained were as follows:

1. Grain yield/fed, yield components were significantly affected by sowing dates and irrigation scheduling treatments in both seasons. Sowing on 1st June and irrigation at 1.2 C.P.E (I_3) gave the highest averages of stem diameter, ear length, ear diameter, grain weight/plant and 100-grain weight in both seasons. Nevertheless, third sowing date (D_3) and irrigation at 0.8 C.P.E (I_1) gave the lowest yield component averages in both seasons.
2. The highest grain yield, i.e. 2476 kg grains/fed was detected from (D_1I_2) in the first season, and 2857 kg grains/fed from (D_1I_3) in the second season. On the contrary, third sowing date (D_3) and irrigation at0.8 C.P.E (I_1) gave the lowest grain yield/fed, i.e. 1955 and 1414.10 kg grains/fed in 2008 and 2009 seasons, respectively.
3. Seasonal consumptive use (ET_C) averaged 61.69 and 61.35 cm in 2008 and 2009 seasons, respectively. The highest ET_C values, i.e. 69.35 and 68.91 cm were recorded from (D_1I_3) in 2008 and 2009 seasons, respectively, whereas, the lowest values, i.e. 54.1 and 53.15 cm in the two successive seasons were resulted from (D_3I_1).
4. The daily ET_C 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. the crop coefficient (K_C) values, for high grain yield were 0.44, 0.70, 1.06, 0.67 and 0.63 for June, July, August, September and October, respectively(as an average in two seasons)
5. The highest water use efficiency, i.e. 0.896 and 0.987 kg grain/m3 water consumed were obtained from (D_1I_2) and (D_1I_3) treatments in 2008 and 2009 seasons, respectively.

Key words: Maize yield, Yield component, Sowing dates, Irrigation scheduling, Water relations.

INTRODUCTION

Maize (*Zea Mays L.*) is one of the most important summer cereal crops grown in Egypt. Maize grain is used for both human and poultry consumption. Therefore, increasing maize production is very important concern. Adequate supply of irrigation water and optimum sowing date are two main factors directly affecting the growth and productivity of maize plants. **Sanjeev *et al.* (2004)** pointed out that the optimum sowing date significantly produced higher cob and fodder yields together with other yield attributes such as diameter of cobs, length of cob and number of grains per cob compared to earlier sowing dates. **Keshav *et al.* (2005)** concluded that the early sowing date (16th June) gave significantly higher values for all yield parameters then other dates of sowing (30th June and 21st July). **Berzsenyi and Dang (2008)** found that the highest yields were obtained for early and optimum sowing dates (8.712 and 8.706 t/ha), compared with later sowing date, a delay of ten or twenty days led to yield losses of 5% and 12.5% for late and very late sowing dates respectively. **Hamada *et al.* (2008)** showed that grain yield was decreased by 9.58% and 23.10% when planting date delayed from May to June and from June to July, respectively. **Salam and Al-Mazrooe (2007)** reported that increasing season duration of maize from 90 to 100 or 110 days increased seasonal consumptive use (ET_C).

Regarding the effect of irrigation treatments on maize crop and water relations, **Doorenbos *et al.* (1979)** reported that water requirement of maize for maximum production varied between 430-490 mm per season depending on climate and season length. **Musick and Duesk (1982)** reported that water deficit affected maize yield and irrigation requirements was 400mm for grain yield of 9.52-10.85 t/ha., whereas water use efficiency (WUE) was 1.25-1.45 kg/m^3. **El-Noemani *et al.* 1990, Ibrahim *et al.* 1992 and Atta- Allah 1996** revealed that extending the irrigation intervals for maize crop reduced vegetative growth, yield components and grain yield/fed. **Sharaan *et al.* (2002)** concluded that increasing irrigation intervals from 10 to 20 days significantly decreased grain yield from 3641.9 to 2868.9 kg/fed, seasonal ET_C from 59.9 to 55.3 cm, daily ET_C from 5.25 to 4.86 mm/day, WUE from 1.445 to 1.340 kg grains/m^3 water. The crop coefficient (K_C) values were 0.74, 0.913, 1.110 and 0.270 for June, July, August and September, respectively. **El-tantawy *et al.* (2007)** showed that growth and yield attributes were increased with increasing irrigation water (IW): C.P.E (cumulative pan evaporation) ratio. The highest ETC (6032 m^3/ha) was resulted from irrigation at 1.2 C.P.E. The highest WUE was obtained from the same treatment. **Abdel-Maksoud *et al.* (2008)** revealed that increasing irrigation intervals from 7 to 14 or 21 days significantly reduced all yield components, grain yield/fed by 15.8%, ET_C by 10.8%, daily ET_C during all the growing season months and the highest daily ETc occurred during August. Irrigation every 14 days gave the highest WUE values (0.972 kg grains/m^3 water consumed). The K_C values were 0.53, 0.74, 0.99 0.71 and 0.62 for June, July, Aug., Sep. and October months, respectively.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of Tameia Agric.Res. Station, Fayoum Governorate during the summer seasons of 2008 and 2009 to study the effect of sowing date and irrigation scheduling treatments on maize crop and crop water relations. To achieve these targets three sowing dates treatments, i.e. D_1: planting on 1st of June, D_2: planting on10th of June and $D_:$ planting on 20th of June, were combined with three irrigation scheduling treatments, i.e. I_1: irrigation at 0.8 cumulative pan evaporation (C.P.E.), $I_{2:}$ irrigation at 1.0 C.P.E., and I_3: irrigation at 1.2 C.P.E. and arranged in a split-plot design with four replications. The effect of different experimental treatments on grain yield, and yield component as well as crop water relations was studied. Calcium super phosphate at (15.5% P_2O_5) at the rate of 150 Kg was added during field preparation. Nitrogen fertilization (ammonium nitrate 33.5%N) at the rate of 120 Kg N/fed was added at three equal doses (at planting, 1^{st} and 2^{nd} irrigations). Maize hybrid (TWC, 310) were sown at the rate of 15 Kg grains/fed in hills of 25cm apart during the two seasons. Application of irrigation scheduling treatments started from the 2^{nd} irrigation. Grain Ears were harvested on Oct. 5^{th} for the first sowing date and 12^{th} for the two other sowing dates in the two successive seasons. The soil physical and chemical properties of the experimental plots were determined according to **Klute (1986)** and **Page *et al.* (1982)** and presented in Table **(1)**. The monthly averages of climatic factors for Fayoum Governorate during the two growing seasons are shown in Table **(2)**. The soil moisture constants of the experimental field (mean of the two seasons) are listed in Table **(3).** Dates of irrigation and irrigations number for different treatments in 2008 and 2009 seasons were recorded in Table (4)**.** The soil moisture values were determined gravimetrically on oven dry basis, as the technique of Water Requirements and Field Irrigation Dept., A.R.C., Egypt for different layers, each of 15.0 cm from soil surface and down to 60 cm depth. At harvesting time the following data were recorded for each sub-plot.

I. Yield and yield component;

1- Ear length (cm) 2- Ear diameter (cm) 3- Grain weight/plant (g)
4-100 grain weight (g) 5-Grain yield (Kg/fed)

All the measurements and data collected were subjected to the statistical analysis according to the methods described by **Snedecor and Cochran (1980).**

II. Crop water relations:

1. Seasonal consumptive use (ET_C)

For obtaining the crop water consumptive use (ET_C), soil samples were taken just before and 48 hours after each irrigation, as well as at harvest time. The crop water consumptive use between each two successive irrigations was calculated according to the following equation **(Israelsen and Hansen, 1962).**

$$Cu\ (ET_C) = \{(Q_2-Q_1) / 100\} \times Bd \times D$$

Where: Cu = crop water consumptive use (cm).
Q2= soil moisture percentage 48 hours after irrigation.
Q1= soil moisture just before irrigation.
Bd = soil bulk density (g/cm^3).
D = soil layer depth (cm).

2. Daily ET_C rate (mm/day). Calculated from the ET_C between each two successive irrigations divided by the number of days.

3. Reference evapotranspiration (ET_0)

Estimated as a monthly rate (mm/day), using the monthly averages of climatic factors of Fayoum Governorate and the procedures of the **FAO-Penman Monteith** equation **(Allen *et al.* 1998)**

4. Crop Coefficient (K_C).

The crop coefficient was calculated as follows:

$$K_C = ET_C / ET_0$$

Where: ET_C = Actual crop evapotranspiration and ET_0 = Reference evapotranspiration.

5. Water use efficiency (WUE).

The water use efficiency as kg grains/ m3 water consumed was calculated for different treatments as the method described by **Vites (1965):** WUE = grain yield (kg/fed.) / Seasonal crop consumptive use "Cu"(m^3/fed.

Table (1): Physical and chemical analysis of the experimental field duri 2008 and 2009 09 seasons (average of two seasons).

Physical properties					
sand%	Silt%	Clay%	Texture classes	Organic matter%	$CaCo_3$%
38.00	21.2	40.8	Clay loam	1.68	5.18

Chemical analysis										
Soluble cations meq/L				Soluble anions meq/L				EC dS/m	pH 1:2.5 Extract	CEC meq/ 100 g soil,
Ca^{++}	Mg^{+}	Na^{+}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{--}	SO_4^{--}			
8.18	7.69	23.67	0.33	20.73	3.06	–	16.08	4.00	8.12	31.83

Table (2): The monthly averages of climatic factors for Fayoum Governorate during 2008 and 2009 seasons.

Month	Year	Temperature C°			Relative humidity (%)	Wind speed(m/sec)	Pan evaporation (mm/day)
		Max.	Min.	Mean			
June	2008	9.4	2.0	30.7	49	2.99	7.80
	2009	8.2	0.4	29.3	44	3.01	8.18
July	2008	37.7	22.1	29.9	50	2.58	7.90
	2009	38.5	22.7	30.6	47	2.58	8.41
August	2008	38.6	22.2	30.4	53	2.42	7.00
	2009	37.0	21.8	29.4	48	2.44	7.62
September	2008	35.9	20.0	28.0	50	2.58	6.56
	2009	35.2	20.7	27.9	50	2.60	6.69
October	2008	31.5	17.2	24.4	52	2.78	4.90
	2009	31.7	18.1	24.9	49	2.77	4.69

Table (3): The average values of soil moisture constants for the experimental field during 2008 and 2009 seasons (average of the two seasons).

Soil depth(cm)	Field capacity (%)	Wilting point (%)	Bulk density(g/cm^3)	Available moisture (%)
0-15	42.46	21.06	1.41	21.4
15-30	40.73	19.81	1.43	20.92
30-45	38.12	18.55	1.31	19.57
45-60	33.55	17.32	1.39	16.23

RESULTS AND DESCUTION

I. Yield and yield components

1- Yield components

The results in Table (5) reveal that all yield components were significantly affected by maize sowing dates in both seasons. Sowing on June 1st gave the highest averages of yield components, whereas, the lowest ones were obtained from sowing on June 20th, in both seasons. Delying sowing date from June 1st to June 20th significantly decreased ear length, ear diameter, grain weight/ plant and 100-grain weight in 2008 season by 6.74, 13.84, 6.76 and 4.56%, respectively, whereas in 2009 season by 16.10, 14.98, 17.03 and 23.66%, respectively. These results may be due to that delaying sowing date will reduce the vegetative and reproductive growth periods which in turn reduce dry matter accumulation in plant organs. These results are in agreement with those reported by **Sanjeev *et al*. (2004), Keshav *et al.* (2005) and Hamada *et al.* (2008).**

The data recorded in Table (5) show that the averages of maize yield components were significantly differe due to irrigation treatments in both seasons. Irrigation at 1.2 C.P.E. gave the highest averages of yield components, whereas the lowest ones were detected from irrigation at 0.8 C.P.E. (long intervals). These results were found to be true in both seasons. It is obvious that increasing irrigation scheduling rate from 0.8 to 1.2 C.P.E. significantly increased ear length, ear diameter, grain weight/ plant and 100-grain weight in 2008 season by 5.09, 19.8, 9.36 and 6.6%, and in 2009 season by 4.2, 23.3, 6.8 and 12.9%, respectively. It could be concluded that irrigation at short intervals (1.2 C.P.E.) increased all yield components. Such findings can be attributed to the more available moisture in the root zone, which in turn increased photosynthesis, cell division and dry matter accumulation in the reproductive organs. The obtained results are in agreement with those found by **El-Noemani *et al.* (1990), Ibrahim *et al.* (1992), El-Tantawy *et al.* (2007) and Abdel-Maksoud *et al.* (2008)**.

Results of Table (5) indicate that maize yield components were significantly affected by the interaction between sowing dates and irrigation scheduling treatments in 2009 season only (except ear length). The highest averages of yield components were detected from first sowing date and irrigation at 1.2 C.P.E. However, the lowest averages were obtained from the third sowing date and irrigation at 0.8 C.P.E.

2- Grain yield (kg/fed.).

The results in Table (5) show that grain yield was significantly affected by sowing dates in both seasons. The highest grain yield i.e. 2266 and 2244.57 kg/fed in 2008 and 2009 seasons, respectively, were resulted from the first sowing date (1st June). However, delaying sowing date to 20th June gave the lowest averages of grain yield/fed i.e. 2052 and 1691.47 kg/fed in the two successive seasons, respectively. On the other hand, delaying sowing date from 1st to 10th June reduced the grain yield by 7.06 and 12.03% in the first and second seasons, respectively. These results indicated that the highest yield recorded in first sowing date compared with late sowing(D_2 and D_3) may be due to the fact that the crop gets sufficient time for its growth and development under suitable climatic conditions compared to late sowing. These results confirm the findings of **Berzsenyi and Dang (2008) and Hamada *et al.* (2008)**.

Table 4

The data recorded in Table (5) reveal that irrigation scheduling treatments significantly affected grain yield in both seasons. Irrigation of maize plants at 1.0 C.P.E gave the highest grain yield, i.e. 2259 kg/fed in 2008 season. Whereas, in 2009 season the highest grain yield was obtained from irrigation at 1.2 C.P.E. i.e. 2407.39. On the other hand, irrigation at 0.8 C.P.E gave the lowest grain yields, i.e. 2025 and 1619.9 kg/fed, in the two successive seasons. Decreasing irrigation intervals from irrigation at 0.8 to 1.0 and 1.2 C.P.E significantly increased grain yield in 2008 season by 10.36 and 5.37%, and in 2009 season by 13.99 and 32.75% respectively. These results may be refered to the effect of water deficit, resulted from irrigation at long intervals in 0.8 C.P.E treatment, which in turn reduced yield components and consequently grain yield. The results are in full agreement with those found by **Atta- Allah (1996)**, **El-Tantawy *et al.* (2007) and Abdel-Maksoud *et al.* (2008)**.

The data in Table (5) indicate that the averages of grain yield weren't significantly affected by the interaction between sowing dates and irrigation treatments in 2008 season, but there were significantly increased in the second season (2009). The first sowing date and frequent irrigation at 1.0 C.P.E gave the highest average of gain yield i.e. 2476 kg/fed in first season. However, the first sowing date and frequent irrigation at 1.2 C.P.E gave the highest average of grain yield i.e. 2857.8 kg/fed in second season. Whereas, the lowest averages, i.e. 1955 and 1414.10 kg/fed were obtained from third sowing date and irrigation at 0.8 C.P.E in the first and second seasons, respectively.

II. Crop water relations.

1- Seasonal consumptive use (ET_C).

The results in Table (6) showe that the values of seasonal consumptive use (ET_C) of maize crop, as a function of sowing date and irrigation scheduling treatment were 61.69 and 61.35 cm in 2008 and 2009 seasons, respectively. Delaying sowing date from 1st June to 10th June and 20th June decreased seasonal ET_C by 4.06 and 11.47% in 2008 season, and by 4.76 and 11.97% in 2009 season respectively. Such results may be due to the reduction in evapotranspiration which related to reduce the long season of growth. These results are in the same trend with the results previously reported by **Salam and Al-Mazrooe (2007).**

The data recorded in Table (6) reveal that irrigation at 1.2 C.P.E gave the highest values of seasonal ET_C, i.e. 65.24 and 65.07 in the two successive seasons. Whereas, the lowest ET_C values, i.e. 58.38 and 57.23 cm in the two successive seasons, were resulted from irrigation at 0.8 C.P.E (long intervals). Decreasing irrigation intervals from irrigation at 0.8 to 1.0 and 1.2 C.P.E increased seasonal ET_C in 2008 season by 5.94 and 10.52%, and in 2009 season by 7.30 and 12.05%, respectively. These results may be attributed to that irrigation at 1.2 C.P.E (frequent irrigation) increased the available soil moisture in the root zone of plants and this may be increased the transpiration process from the plant vegetation. These results are in harmony with those found by **Sharaan *et al.* (2002), El-Tantawy *et al.* (2007) and Abdel-Maksoud *et al.* (2008).**

Regarding the effect of interaction, data recording in Table (6) indicate that the first sowing date and irrigation at 1.2 C.P.E gave the highest value of seasonal ET_C in the two successive seasons, i.e. 69.35 and 68.91 cm, respectively. While the third sowing date and irrigation at 0.8 C.P.E gave the lowest value of seasonal ET_C, i.e. 54.10 and 53.15 cm, in the two successive seasons, respectively.

Table 5

Table (6): Effect of sowing dates and irrigation scheduling on seasonal consumptive use of maize crop (ET_C) in cm.

Sowing dates	2008				2009			
	0.8	1.0	1.2	Mean	0.8	1.0	1.2	Mean
D_1 1/6	62.17	65.77	69.35	65.06	60.83	65.16	68.91	64.97
D_2 10/6	58.87	62.49	65.61	62.42	57.71	62.37	65.57	61.88
D_3 20/6	54.10	57.96	60.75	57.60	53.15	57.69	60.74	57.19
Mean	58.38	62.07	65.24	61.69	57.23	61.74	65.07	61.35

2- Daily ET_C rate (mm/day).

The data listed in Table (7) generally indicate that the daily ET_C rates, as a function of the different treatments under this study started with low values during June, i.e. (3.62 and 3.32 mm/day), then increased during July (5.31 and 5.40 mm/day), and reached its maximum values (7.35 and 7.37 mm/day) during August in 2008 and 2009 seasons, respectively, and declined again during September to reach low values during October (harvesting). Such findings may be attributed to that during June most of water losses was caused by evaporation from the bare soil. Thereafter, the daily ET_C rate increased as the crop cover increase because transpiration took place beside evaporation to reach the peak rates at tasseling and silking period. The ET_C rate tended to decrease again during September (grain filling stage) and October (harvesting).

The results in Table (7) show that delaying sowing date from 1^{st} June to 10^{th} June and 20^{th} June decreased the daily ET_C rates during the months of maize growing season duration from June until October in both seasons.

The data presented in Table (7) reveal that irrigation maize plants at 1.2 C.P.E (frequent irrigation) increased the daily ET_C rate during the growing season, in both seasons. However, irrigation at 0.8 C.P.E gave the lowest results. These results may be attributed to the high available moisture in the root zone resulted from short irrigation intervals (frequent irrigation), which in turn increased the evapotranspiration rate during the growing season months. Similar results were obtained by **El-Tantawy *et al.* (2007) and Abdel-Maksoud *et al.* (2008).**

3- Reference evapotranspiration (ET_0).

The daily ET_0 rates during maize growing season in 2008 and 2009 seasons are presented in Table (8). The daily ET_0 values (mm/day) were calculated using the FAO-Penman-Monteith equation and meteorological data of Fayoum Governorate (Table, 2). From June to October in both growing seasons. The obtained results in Table (8) indicate that the daily ET_0 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 ET_0 are depend mainly on the evaporative power of the air (temperature, humidity, wind speed and solar radiation).

Table 7

4- Crop coefficient (K_C).

The crop coefficient reflects the crop cover percentage and soil conditions on the ET_0 values. The K_C values were estimated from the daily ET_C rates (Table, 7) and the daily ET_0 rates (Table, 8) during the two growing seasons. The results in Table (8) reveal that the K_C values, as a function of the interaction between sowing dates and irrigation scheduling treatments (as overall mean) were low during June (initial growth stages) which reached 0.40 in the two successive seasons. Thereafter, the values increased to be 0.65 in the two successive seasons, during July (vegetative growth stage) to reached its maximum values during August, i.e. 0.96 and 0.97 (tassling and silking stage) in the two successive season, respectively. The K_C values seemed to be decreased again during September up to 0.61 in the two seasons (grain filling-maturity) and reached its minimum values, i.e. 0.54 and 0.55 in 2008 and 2009 seasons during October (harvesting stage), respectively. Such results can be referred to the large diffusive resistance to bare soil at the initial stage, which reduced with increasing the crop cover percentage until heading and grain formation, and then tended to be reduced again at maturity stage. Data in Table (8) show that delaying sowing date from 1st June to 10th June and 20th June decreased the K_C values during the growing season and this trend was true in both seasons of the study. First sowing date gave the highest K_C values, whereas, the lowest values were detected from the third sowing date in the two growing seasons. On the other hand, decreasing irrigation intervals from 0.8 to 1.0 and 1.2 C.P.E increased the K_C values in all months of the growing season duration in 2008 and 2009.

Finally, the K_C values of maize for high production were 0.44, 0.70, 1.05, 0.66 and 0.62 in 2008 season, and 0.44, 0.70, 1.07, 0.68 and 0.63 in 2009 season, during June, July, August, September and October, respectively, under (D_1I_3) treatments.

5-Water use efficiency (WUE).

The results presented in Table (9) clearly show that the mean values of WUE, as a function of different tested treatments, were 0.826 and 0.758 kg grains/m^3 water consumed in 2008 and 2009 seasons, respectively. It is evident that the effect of sowing date on WUE value was different in 2008 season compared to that of 2009 season. The highest value of WUE in 2008 season was detected from the third sowing date, i.e. 0.849 kg grains/m^3 water consumed, meanwhile, the first sowing date gave the highest WUE value in 2009, i.e. 0.816 kg grains/m^3 water consumed.

Data listed in Table (9) indicate that irrigation at 1.0 C.P.E gave the highest WUE value, i.e. 0.867 kg grains/m^3 water consumed in 2008 season. Whereas, in 2009 season, the highest value of WUE, i.e. 0.876 kg grains/m^3 water consumed was detected from 1.2 C.P.E.

Data in Table (9) show that the highest WUE value, i.e. 0.896 kg grains/m^3 water consumed was obtained from (D_1I_2) in 2008 season. Whereas, in 2009 season, the highest WUE, i.e. 0.987 kg grains/m^3 water consumed was obtained under (D_1I_3). These results are in harmony with the results reported by **El-Tantawy *et al.* (2007) and Abdel-Maksoud *et al.* (2008).**

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 TWC 310) at the first week of June and irrigating at 1.0 or 1.2 C.P.E.

Table (8): Reference evapotranspiration, ET_0 (mm/day) and K_C for maize crop during 2008 and 2009 seasons as affected by sowing dates and irrigation scheduling treatments.

Treatments		2008					2009				
Sowing dates	Irrigation scheduling	June	July	August	Sept.	Oct.	June	July	August	Sept.	Oct.
Reference ET_0 mm/day		8.95	8.10	7.65	6.76	5.39	8.20	8.33	7.58	6.40	5.75
D_1 1/6	0.8	0.40	0.62	0.94	0.60	0.52	0.39	0.63	0.94	0.59	0.54
	1.0	0.41	0.68	0.99	0.63	0.53	0.43	0.67	1.01	0.62	0.57
	1.2	0.44	0.70	1.05	0.66	0.62	0.44	0.70	1.07	0.68	0.63
	Mean	0.42	0.67	0.99	0.63	0.56	0.42	0.67	1.01	0.63	0.58
D_2 10/6	0.8	0.39	0.61	0.91	0.55	0.51	0.38	0.61	0.90	0.56	0.51
	1.0	0.40	0.65	0.96	0.62	0.52	0.41	0.64	0.98	0.61	0.53
	1.2	0.42	0.69	1.00	0.65	0.56	0.42	0.68	1.02	0.66	0.60
	Mean	0.40	0.65	0.96	0.61	0.53	0.40	0.64	0.97	0.61	0.55
D_3 20/6	0.8	0.38	0.60	0.89	0.54	0.50	0.37	0.60	0.87	0.55	0.48
	1.0	0.39	0.63	0.95	0.62	0.51	0.39	0.63	0.97	0.60	0.52
	1.2	0.41	0.67	0.99	0.63	0.55	0.41	0.67	0.99	0.65	0.58
	Mean	0.39	0.63	0.94	0.59	0.52	0.39	0.63	0.94	0.60	0.53
Mean of irrigation											
0.8		0.39	0.61	0.91	0.56	0.51	0.38	0.61	0.90	0.57	0.51
1.0		0.40	0.65	0.97	0.63	0.52	0.41	0.65	0.99	0.61	0.54
1.2		0.42	0.69	1.01	0.65	0.58	0.42	0.68	1.03	0.66	0.60
Over all mean		0.40	0.65	0.96	0.61	0.54	0.40	0.65	0.97	0.61	0.55

Table (9): Effect of sowing dates, irrigation scheduling treatments and their interaction on water use efficiency of maize in 2008 and 2009 seasons.

Treatments	2008				2009			
Sowing dates	Irrigation scheduling				Irrigation scheduling			
	0.8	1.0	1.2	Mean	0.8	1.0	1.2	Mean
D_1	0.806	0.896	0.765	0.822	0.685	0.777	0.987	0.816
D_2	0.816	0.837	0.768	0.807	0.699	0.700	0.869	0.756
D_3	0.860	0.869	0.817	0.849	0.634	0.698	0.772	0.701
Mean	0.827	0.867	0.783	0.826	0.673	0.725	0.876	0.758

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الاستهلاك المائي ومحصول الحبوب للذرة الشامية وعلاقته بجدولة الري ومواعيد الزراعة

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أقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بطامية – محافظة الفيوم – خلال موسمى الزراعة ٢٠٠٨ ، ٢٠٠٩ لدراسة تأثير مواعيد الزراعة وجدولة الري علي محصول الذرة الشامية ومكوناته (هجين ثلاثي ٣١٠) وبعض العلاقات المائية للمحصول. ولتحقيق ذلك تفاعلت ثلاثة مواعيد للزراعة وهي D_1: 1/6، D_2:10/6 ، D_3: 20/6 مع ثلاث معاملات لجدولة الري وهي (١) الري عند ٠.٨، (٢) الري عند ١.٠، (٣) الري عند ١.٢ من البخر التراكمي لوعاء البخر القياسي في تصميم القطع المنشقة مرة واحدة في اربعة مكررات.

وفيما يلي ملخص لأهم النتائج المتحصل عليها:

١. تأثر محصول الفدان ومكونات المحصول معنويا بمواعيد الزراعة وكذلك بمعاملات جدولة الري .
٢. أدت الزراعة في الموعد الاول (٦/١) وكذلك الري عند ١.٢ بخر تراكمي للوعاء لانتاج أعلي المتوسطات لكل من طول الكوز وقطر الكوز ووزن حبوب النبات ووزن ال ١٠٠ حبة في كلا الموسمين، بينما أدت الزراعة في الموعد الثالث والري عند ٠.٨ بخر تراكمي للوعاء الى انتاج أقل المتوسطات.
٣. نتج أعلي محصول حبوب وهو ٢٤٧٦، ٢٨٥٧.٨ كجم/ف في ٢٠٠٨ ، ٢٠٠٩ علي الترتيب من موعد الزراعة الاول وكذا الري عند ١.٠ بخر تراكمي للوعاء فى الموسم الأول، ١.٢ بخر تراكمي للوعاء فى الموسم الثاني بينما أدت الزراعة في الموعد الثالث والري عند ٠.٨ بخر تراكمي للوعاء الى الحصول علي أقل محصول حبوب وهو ١٩٥٥، ١٤١٤.١٠ كجم/ف في موسمي ٢٠٠٨، ٢٠٠٩ علي الترتيب.
٤. متوسط الاستهلاك المائي الموسمي هو ٦١.٦٩، ٦١.٣٥سم في موسمي ٢٠٠٨، ٢٠٠٩ علي الترتيب وأعلي قيم الاستهلاك المائي الموسمي وهي ٦٩.٣٥، ٦٨.٩١سم في ٢٠٠٨، ٢٠٠٩ علي الترتيب قد نتجت من الزراعة في الموعد الاول والري عند ١.٢ بخر تراكمي للوعاء بينما أقل قيم للاستهلاك المائي الموسمي وهي ٥٤.١٠، ٥٣.١٥ سم في ٢٠٠٨، ٢٠٠٩ علي الترتيب قد نتجت من الزراعة في الموعد الثالث والري عند ٠.٨ بخر تراكمي للوعاء.
٥. كان معدل الاستهلاك المائي اليومي للمحصول منخفضاً خلال يونية ثم إزداد خلال يوليو ليصل الي قمة الاستهلاك خلال أغسطس ثم انخفض خلال سبتمبر وأكتوبر في كلا الموسمين ، وكان ثابت المحصول للمعاملة التي اعطت أعلي محصول حبوب (كمتوسط للموسمين) هو ٠.٤٣، ٠.٦٩، ١.٠٣، ٠.٦٦، ٠.٥٨ خلال يونيو ويوليو وأغسطس وسبتمبر وأكتوبر علي الترتيب.
٦. نتجت أعلي كفاءة استهلاك للماء وهي ٠.٨٩٦ ، ٠.٩٨٧ كجم حبوب/ م٣ ماء مستهلك في ٢٠٠٨، ٢٠٠٩ علي الترتيب من الزراعة في الموعد الاول والري عند ١.٠ بخر تراكمي للوعاء في العام الاول بينما كانت في الموعد الاول والري عند ١.٢ بخر تراكمي للوعاء في العام الثاني.