Impact of Irrigation Intervals and Fertilization on Actual Evapotranspiration and Wheat Production

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$\mathbf{F}$IELD experiments were conducted in clay loam soil during two successive seasons 2010/2011 and 2011/2012 at the Agricultural Experimental station, Faculty of Agriculture, Cairo University to investigate the impact of 4 irrigation frequencies combined with three fertilizers as well as control treatment (without fertilizer) on actual evapotranspiration (ETa), grain yield (*Triticum aestivum*, L. Sids1) and water use efficiency (WUS) of wheat under furrow irrigation system and Giza region conditions. The results clearly revealed that increasing irrigation frequency significantly decreased seasonal ETa values during studied growing seasons. While, the addition of inorganic and organic fertilizers to the studied soil significantly increased seasonal ETa compared to the control treatment (without fertilizers). The wheat crop irrigated by short irrigation interval ≤ 14 days with fertilization by combined between inorganic and organic fertilizers increased seasonal ETa values. While, the wheat crop irrigated by the long irrigation interval of 18 days with separately organic fertilizer decreased seasonal ETa value. The results revealed that irrigation interval every 10 days with combined fertilizers treatment had the highest seasonal ETa value (44.56 cm), while the irrigation interval every 18 days with separately organic fertilizer had the lowest seasonal ETa value (37.79 cm) compared to the control treatment (without fertilizers) during studied growing seasons. The results noticed that the effect of irrigation frequencies significantly influenced the grain yield for studied growing seasons. Wheat grain yield values increased by increasing irrigation interval from 10 to 14 days. However, the increasing irrigation interval to 18 days decreased wheat grain yield. The wheat grain yield values significantly increased by addition of combined inorganic and organic fertilizers to the studied soil compared with the control treatment (without fertilizers) during studied growing seasons. The wheat crop irrigated by the short irrigation interval of 14 days with fertilization by combined between inorganic and organic fertilizers increased grain yield values, while, irrigated by the long irrigation interval more than 14 days with separately organic fertilizer decreased grain yield values. Generally, the results showed that increasing irrigation frequency significantly decreased the water use efficiency values of wheat crop during studied growing seasons. The addition of inorganic and organic fertilizers to the studied soil significantly increased wheat WUS compared to the control treatment (without fertilizers). The interaction between

irrigation frequencies and fertilizers types on water use efficiency values of wheat crop was no significant effect. The wheat crop irrigated by short irrigation interval of 14 days with fertilization by combined between inorganic and organic fertilizers increased wheat WUS values, while, irrigated by the long irrigation interval of 18 days with separately organic fertilizer decreased WUS values. Consequently, under furrow irrigation system and Giza region conditions, the irrigation interval of wheat plants must be short interval of 14 days with fertilization by combined between inorganic and organic fertilizers in clay loam soil.

Keywords: Wheat, Water use efficiency, Actual evapotranspiration, Irrigation frequency, Organic and inorganic fertilizers.

Wheat is a very important crop in Egypt. However, its production is not sufficient the local consumption. The production of wheat is mainly depending on the irrigation amount, the time of applied irrigation water, growth stage and fertilization management.

Hussain and Al-Jaloud (1995) reported that the irrigation water amount with high application rate of fertilizers increased the agricultural production of wheat crop.

Majumdar (2002) stated that applied irrigation water before the time of actual crop need encourage losses of water through higher evapotranspiration and deep percolation. Moreover, the delayed irrigation subjected the plant to water and salt stresses, consequently, the growth activities and yield reduced. Information on optimal scheduling of limited amounts of water to maximize yields of high quality crops is essential if irrigation water is to be used most efficiently (Al - Kaisi *et al.*,1997). Therefore, it is essential to develop the most suitable irrigation schedule for different regions, especially as plant water consumption during plant growth depends mostly on soil and climatic conditions (Nath *et al.*, 2001).

Evapotranspiration is basic information required for irrigation scheduling and for crop growth. Knowledge of evapotranspiration under different irrigation frequencies allows improved water management by adjusting the irrigation amount to meet the crop requirements for each irrigation interval. Norwood (2000) reported that irrigation water can be conserved and yields maintained by using appropriate irrigation timing to avoid plant water deficit stress at critical growth stages. Irrigation scheduling has been described as the primary tool to improve water use efficiency, increase crop yields, increase the availability of water resources, and provoke a positive effect on the quality of soil and ground water (FAO, 1996). Also, Kang *et al.* (2002) indicated that the responses of grain yield and water use efficiency to irrigation varied considerably due to differences in soil water contents and irrigation schedules.

Kijne *et al.* (2003) reported that the most effective practice to regulate the water use efficiency was through irrigation regimes. For reducing water use it is

necessary to examine the possibility of further reducing irrigation applied by optimizing the irrigation scheduling (Zhang, *et al*., 1999).

Van Duivenbooden *et al*. (1996) stated that the supply of nutrients, in a suitable form, is also a major factor determining cereal production. The influence of organic matter on soil fertility and physical fertility is well known. Khadr *et al*. (2002) reported that soil organic matter has affected soil chemical, physical and biological properties that in turn contributed to improve crop yield. Organic fertilizers are considered as the most important factor in reducing the application of inorganic fertilizers; consequently, reduce the adverse environmental impact of chemicals major (Marschner, 1995). It was noticed that combined application of organic and inorganic fertilizers can increase the activities of soil available nutrient content (He and Li, 2004). It was also reported that neither inorganic nor organic amendments separately can maintain organic matter status of soil and sustain the productivity (Prasad, 1996). The proper fertilization improved water use efficiency (Pala *et al*., 2007).

The objective of the current study was to investigate the influence of different irrigation frequencies combined with different fertilizers on actual evapotranspiration, water use efficiency and grain yield of wheat.

Material and Methods

Field experiment was conducted at the Agricultural Experimental station, Faculty of Agriculture, Cairo University in Giza region during two successive seasons 2010/2011 and 2011/2012. The Experimental station is located at latitude of 30° 03" N and longitude of 31° 13" E. The physiochemical properties of the soil experimental site are illustrated in Table 1. The soil was classified as clay loam (41 % sand, 29 % silt and 30 % clay) with 1.27g/cm^3 bulk density. Particle size distribution and bulk density were determined accordingly Kulte (1986). The soil chemical properties were determined according to Page (1982).

Wheat seeds (*Triticum aestivum*, L. Sids1) were planted at rate 70 kg/fed on November 26th and 24th and were harvested at the end of April for studied seasons. The agronomic practices followed as recommended wheat production in Giza region. Furrow irrigation system was used in this investigation. The field experiment at the growing season was consisted of 48 experimental plots of 4 irrigation frequencies and 3 fertilizers types as well as control treatment (without fertilizers) with 3 replications. The irrigation frequencies were assigned to the main plots and the fertilizer types were assigned to the subplots. The experimental plot area was 5.0 m x 12 m with a border of 1.5 m between plots. The layout of the experiment was a completely randomized in split plot design with three replicates. The field experiment was comprised 16 treatments combined between 4 irrigation treatments and 4 fertilizer treatments.

TABLE 1. Some physiochemical properties of soil of the experimental site.

Soil properties	Soil depth, cm		
	0 - 20	20 – 40	40 - 60
Soil moisture content at -33 kPa, %	36.85	34.72	32.34
Soil moisture content at -1500 kPa, %	19.52	18.63	15.48
Sand, %	40.79	42.15	49.61
Silt, %	28.85	31.26	20.10
Clay, %	30.36	26.59	30.29
Soil textural class	C. L	C. L	L
Bulk density, gm cm^{-3}	1.27	1.29	1.35
ECe, dSm^{-1}	1.82	2.13	1.65
pH	7.87	8.02	8.12
OM, %	1.92	1.64	1.23

Irrigation treatments

Four irrigation frequencies: the wheat plants were irrigated every 10, 12, 14 and 18 days (T10, T12, T14 and T18).

Fertilizers treatments

- Control treatment without fertilizers (NF).
- The separately inorganic fertilizers with nitrogen, phosphorus and potassium (IF) were added in the form of ammonium nitrate (33.5 % N) at a rate of 75 kg/fed in two doses, one third was added at planting date and the other two thirds were applied after planting by 35 days. Potassium sulphate (48 % K_2O) at a rate of 50 kg/fed and super phosphate (15.5 % P_2O_5) at a rate of 100 kg/fed, were applied as one dose before planting date.
- The separately organic fertilizer (OF) was applied as farmyard manure at a rate of 20 ton/fed before planting date by two weeks.
- Combined fertilizers treatment (CF) included 1/2 dose of inorganic and 1/2 dose of organic studied fertilizer.

Wheat grain yield, ton/fed, were determined at the end of the harvesting growth stage. The volumetric soil moisture content was determined after and before irrigation time for different studied soil depths and the actual evapotranspiration was calculated accordingly (Hansen *et al*., 1979) using the following equation,

$$ETa = ((\theta_2 - \theta_1) / 100) \times D$$

Where, ETa is the actual evapotranspiration, mm/day. The θ_2 and θ_1 are the volumetric soil moisture content after and before irrigation and D is soil depth, mm.

Water use efficiency of wheat crop (WUE) was calculated according to Giriappa (1983) using the following equation,

$$WUE = yield/ ETa,$$

Where, yield is the wheat grain in kg/fed and ETa is actual evapotranspiration during wheat growing season, m³/fed.

The reference evapotranspiration (ETo), mm/day, is calculated using CROPWAT 8 computer program using Penman-Monteith equation using meteorological data of Giza station during studied growing seasons (Table 2). The duration and the crop factor of wheat stages were 20, 40, 64 and 30 days and 0.4, 0.80, 1.2 and 0.7 for initial, development, flowering and harvesting growth stages, respectively, according to Allen *et al*. (1998).

Analysis of variance was used to test the degree of variability among the obtained data. Least significant difference (LSD) test was used for the comparison among treatments means (Sendecor and Cocheran, 1980). Cohort computer program was used for the statistical analysis, version 6.400.

TABLE 2. Meteorological data and reference crop evapotranspiration, mm/day, at Giza station during studied growing seasons.

Month	T-max °C	T-min °C	R.H %	W.S m/sec	*ET_0 mm/day	T-max °C	T-min °C	R.H %	W.S m/sec	*ET_0 mm/day
	Season 2010/2011					Season 2011/2012				
Nov.	27.4	16.1	68	1.2	2.78	24.5	13.3	65	1.3	2.50
Dec.	22.8	10.2	65	0.9	2.14	21.7	10.1	68	1.5	2.05
Jan.	21.2	9.7	68	0.9	1.84	19.2	8.3	61	1.4	2.08
Feb.	22.9	11.3	57	1.3	2.84	20.7	9.0	59	1.4	2.69
Mar.	24.8	11.9	57	1.8	3.98	23.6	11.3	61	1.8	3.76
Apr.	28.4	18.5	51	1.4	4.96	30.7	15.9	51	1.8	5.48

*ETo was calculated according to Penman-Monteith equation.

Results and Discussion

Effect of irrigation frequencies and fertilizer types on seasonal ETa
Concerning the effects of applied irrigation frequencies on seasonal ETa, cm, during 2010/2011 and 2011/2012 growing seasons under furrow irrigation system are illustrated in Table 3. Also, the regression analyses were determined between irrigation frequency time by days (T) and seasonal ETa, cm, under all treatment during studied growing seasons by CoHort computer program version 6.400. A highly significant relation was obtained with multiple regression coefficient is equal 0.619 (n = 95). This relation is illustrated in Fig.1 and expressed in the following polynomial regression equation,

$$ETa = - 0.0436 \ T^2 + 0.5871 \ T + 42.0191$$

The results clearly revealed that increasing irrigation frequency significantly decreased seasonal ETa values during studied growing seasons. The seasonal ETa average ranged between 43.4 and 38.1 and 43.8 to 38.8 cm for first and second growing seasons, respectively (Table 3 and Fig. 1). The highest value of seasonal ETa

was obtained at irrigation every 10 days and the lowest value was obtained at irrigation every 18 days. The lowest seasonal ETa value might be attributed to the applied irrigation water amount was insufficient for the water requirements of wheat crop. The percentage decrease of seasonal ETa values at irrigation every 12, 14 and 18 days relative to the irrigation every 10 days were 2.3, 4.0 & 12.2 % and 1.7, 4.3 & 11.3 % for first and second growing seasons, respectively.

TABLE 3. Actual evapotranspiration, grain yield, and WUS of wheat crop as affected by irrigation frequencies and fertilizer types during studied seasons.

Irrigation frequency	Fertilizer type	ETa cm	Grain yield ton/fed	WUS kg/m³	ETa cm	Grain yield ton/fed	WUS kg/m³
		Season 2010/2011			Season 2011/2012		
T10	NF	41.10	1.98	1.15	41.54	2.07	1.19
	IF	44.19	2.45	1.32	44.65	2.50	1.33
	OF	43.60	2.36	1.29	43.46	2.43	1.32
	CF	44.56	2.49	1.33	45.43	2.56	1.34
	Mean	43.363	2.321	1.272	43.770	2.389	1.295
T12	NF	38.71	1.99	1.23	39.58	2.11	1.28
	IF	43.86	2.48	1.34	44.15	2.63	1.36
	OF	42.79	2.39	1.35	43.46	2.47	1.35
	CF	44.17	2.52	1.36	44.87	2.58	1.37
	Mean	42.383	2.344	1.315	43.015	2.448	1.339
T14	NF	37.58	2.13	1.35	38.04	2.19	1.37
	IF	43.15	2.64	1.46	43.28	2.67	1.47
	OF	42.18	2.53	1.42	42.25	2.56	1.44
	CF	43.69	2.72	1.48	43.95	2.77	1.50
	Mean	41.650	2.503	1.428	41.880	2.548	1.444
T18	NF	33.17	1.83	1.31	34.82	1.95	1.33
	IF	40.07	2.30	1.37	40.39	2.34	1.38
	OF	37.79	2.16	1.36	38.72	2.21	1.36
	CF	41.23	2.41	1.39	41.46	2.46	1.41
	Mean	38.065	2.173	1.357	38.848	2.239	1.371
Mean season		41.365	2.335	1.343	41.878	2.406	1.362
LSD 05 Fertilizer type n = 24		0.639	0.056	0.037	0.639	0.056	0.037
LSD 05 Irrigation frequency n = 24		0.548	0.055	0.012	0.550	0.055	0.012
LSD 05 Season		0.388	0.039	0.008	0.389	0.039	0.008
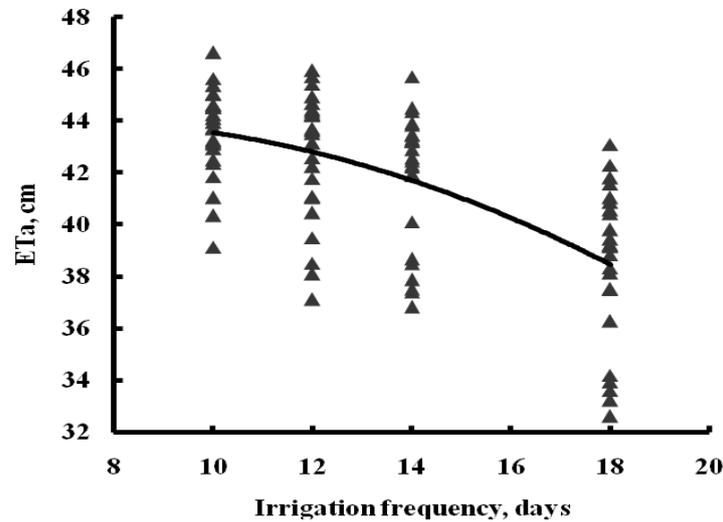
Fig. 1. The actual evapotranspiration of wheat crop as affected by irrigation frequency.

Concerning the effect of the studied fertilizers treatments on seasonal ETa of wheat crop under different irrigation frequencies are represented in Table 3. The results showed that the addition of inorganic and organic fertilizers to the studied soil significantly increased seasonal ETa compared to the control treatment (without fertilizers). The average of seasonal ETa values varied from 43.4 to 37.6 cm for the first growing season and 43.9 to 38.5 cm for the second growing season, respectively. The highest value of seasonal ETa was obtained at combined fertilizers treatment (CF) and the lowest value was obtained at control treatment (IF). The percentage increase values of the seasonal ETa relative to control treatment were 13.8, 10.5 & 15.3 % for the first growing season and 12.9, 9.8 & 14.7 % for the second growing season, respectively. Consequently, the addition of combined between inorganic and organic fertilizers is the best treatment. The lowest increase was obtained at OF treatment. This lowest of seasonal ETa might be attributed to the addition of separately organic fertilizer is insufficient for fertilizer requirements of wheat crop during growing season.

The interaction between irrigation frequencies and fertilizers types on seasonal ETa values was significant (Table 3). The results revealed that irrigation interval every 10 days with combined fertilizers treatment (CF) had the highest seasonal ETa value, while the irrigation interval every 18 days with organic fertilizer treatment (OF) had the lowest seasonal ETa value compared to the control treatment during studied growing seasons. These results indicated that the wheat crop irrigated by short irrigation interval ≤ 14 days with fertilization by combined between inorganic and organic fertilizers increased seasonal ETa

values. While, the wheat crop irrigated by the long irrigation interval > 14 days with separately organic fertilizer decreased seasonal ETa value. Consequently, the irrigation interval of wheat plants must be short interval of ≤ 14 days with addition combined between inorganic and organic fertilizers.

Effect of irrigation frequencies and fertilizers types on wheat grain yield

Wheat grain yield values, ton/fed, as affected by irrigation frequencies are illustrated in Table 3. The polynomial relationship between irrigation frequency time by days (T) and wheat grain yield ton/fed under all treatments during studied growing seasons were estimated by CoHort computer program version 6.400 and demonstrated in Fig. 2. A highly significant relation was obtained with the coefficient of multiple determination is equal 0.418 (n = 95) and expressed in the following regression equation,

$$\text{Wheat grain yield} = -0.0129\ T^2 + 0.3464\ T + 0.1575$$
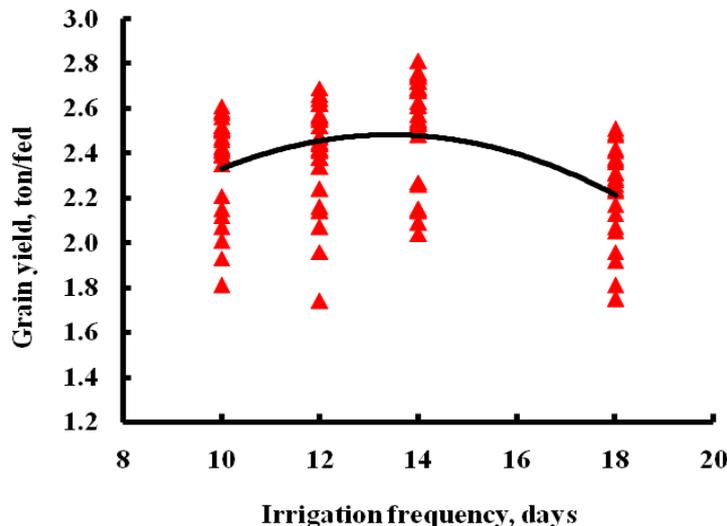
Fig. 2. The grain yield of wheat crop as affected by the irrigation frequency.

The results noticed that the irrigation frequencies significantly influenced grain yield for studied growing seasons. Wheat grain yield values increased by increasing irrigation interval from 10 to 14 days. While, the increasing irrigation interval to 18 days decreased wheat grain yield (Table 3 and Fig. 2). The wheat grain yield average ranged between 2.50 to 2.17 and 2.55 to 2.24 ton/fed for the first and second growing seasons, respectively. The highest wheat grain yield was obtained at plants irrigated every 14 days, while, the lowest grain yield was recorded at wheat plants irrigated every 18 days. Several researches suggested that increasing irrigation frequency could compensate for certain nutrient deficiencies and reduced grain yield of wheat plants irrigated less frequently may

be a result of nutrient shortages rather than water shortage (Buljovcic and Engels, 2001, Silber *et al*., 2003 and Xu *et al*., 2004). The results revealed that the irrigation interval every 10 or 18 days decreased the wheat grain yield as compared to irrigation interval 14 days (Table 3). The reason of the decrease obtained at the irrigation interval every 10 days might be attributed to the seasonal ETa was higher than the consumptive use of wheat crop and increased the storage water in the active root zone. This increase of water may be caused the partially poor aeration at active root zone and leaching of soil nutrients, consequently, the wheat grain yield values reduced. These results are agreed with that reported by Xiao *et al*. (2004). While, the decrease of wheat grain yield values obtained at the irrigation interval every 18 days might be attributed to the seasonal ETa value was less than the consumptive use of wheat crop, consequently, the wheat grain yield values reduced. The percentage increase of wheat grain yield values at irrigation interval every 12 and 14 days compared to the irrigation interval every 10 days were 1.0 & 7.8 % and 2.4 & 6.6 % for the first and second growing seasons, respectively. The percentage decrease of wheat grain yield values at irrigation interval every 18 days relative to the irrigation interval every 10 days were 6.4 % for the studied growing seasons.

Concerning the effect of the studied fertilizers treatments on wheat grain yield, ton/fed, the data noticed that grain yield values significantly increased by addition of inorganic and organic fertilizers to the studied soil compared with the control treatment (without fertilizers) during studied growing seasons. These results are in agreement with Juo and Kangna (1989) who stated that the application of mineral fertilizer is an effective means of increasing yield, however, separately mineral fertilizer cannot sustain yields unless combined with other affordable and sustainable technology such as the use of compost or farmyard manure. Average wheat grain yield values varied from 1.98 to 2.53 ton/fed for the first growing season and 2.08 to 2.59 ton/fed for the second growing season, respectively. The highest value of wheat grain yield was obtained at combined fertilizers treatment (CF) and the lowest value was obtained at the control treatment (NF). The percentage increase values of the wheat grain yield relative to control treatment were 24.5, 19.1 & 27.9 % for IF, OF and CF fertilizers treatments during the first growing season and 23.1, 17.7 & 26.2 % for the same treatments during the second growing season, respectively. Consequently, the addition of combined between inorganic and organic fertilizers is the best treatment under studied treatments. The lowest increase was obtained at OF treatment. The addition of separately studied organic fertilizer is insufficient for fertilization requirements of wheat crop during growing season.

The interaction between irrigation frequencies and fertilizers types on wheat grain yield values was no significant effect. The results showed that the irrigation interval every 14 days with combined fertilizers treatment (CF) had the highest grain yield value, while irrigation interval every 18 days with organic fertilizer treatment (OF) had the lowest value compared to the control treatment during

studied growing season. These results indicated that the wheat crop irrigated by irrigation interval of 14 days with fertilization by combined between inorganic and organic fertilizers increased grain yield value, while, irrigated by the long irrigation interval > 14 days with separately organic fertilizer decreased grain yield values. Thus, the irrigation interval of wheat plants must be 14 days with addition combined between inorganic and organic fertilizers. The wheat plants irrigated by long irrigation interval might be subjected to water stress. Moreover, the separately organic fertilizer could not depress the harmful effect of water stress, then, the grain yield reduced.

Water use efficiency (WUE)

Concerning the effect of applied different irrigation frequencies on water use efficiency values, kg/m^3, of wheat crop during studied growing seasons under furrow irrigation system are shown in Table 3. Generally, the results showed that increasing irrigation frequency significantly decreased the water use efficiency values of wheat crop during studied growing seasons. The polynomial relationship between irrigation frequency time by days (T) and WUS, kg/m^3, for studied growing seasons of wheat crop were determined by CoHort computer program version 6.400 (Fig. 3). A highly significant relation was obtained with the coefficient of multiple determination is equal 0.540 (n = 95) and expressed in the following regression equation,

$$WUS = -0.0057 \, T^2 + 0.1708 \, T + 0.1285$$
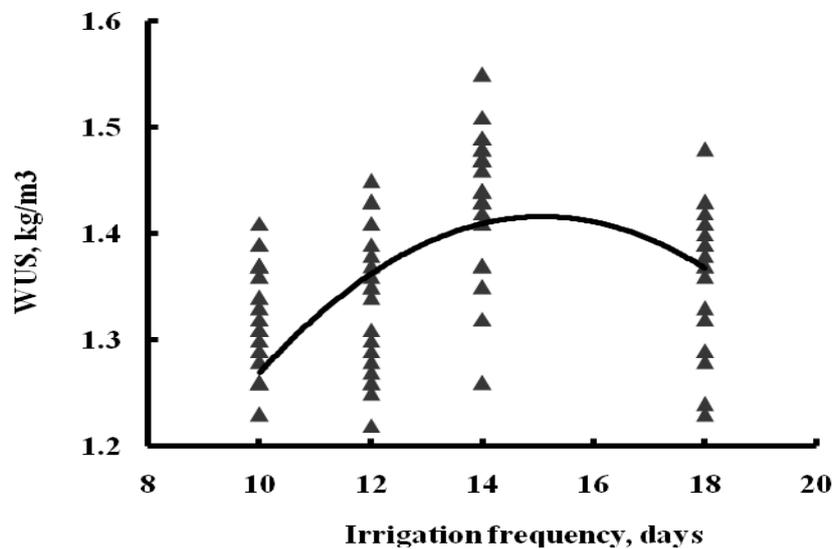
Fig. 3. The water use efficiency of wheat crop as affected by the irrigation frequency.

The WUS average of wheat crop varied from 1.27 to 1.43 and 1.30 to 1.44 kg/m^3 for the first and second growing seasons, respectively. The highest value of wheat WUS was obtained at irrigation interval every 14 days and the lowest value was obtained at irrigation interval every 10 days under studied growing seasons. The percentage increase of water use efficiency values at irrigation interval every 12, 14 and 18 days compared to the irrigation interval every 10 days were 3.4, 8.6 & 5.0 % and 3.4, 7.8 & 5.1 % for the first and second seasons, respectively. Karam *et al.* (2003) stated that the plants were subjected to water stress had higher WUE values than that obtained for the plants without deficit irrigation water. The relatively higher wheat WUE obtained with irrigation interval of 18 days attributed to the ETa values were less than the consumptive use of wheat during the growing season and caused the wheat grain yield reduced.

Concerning the effect of the studied fertilizers treatments on water use efficiency of wheat crop under different irrigation frequencies are shown in Table 3. The results revealed that the addition of inorganic and organic fertilizers to the clay loam soil significantly increased wheat WUS compared to the control treatment (without fertilizers). The average values of wheat water use efficiency ranged between 1.26 to 1.39 kg/fed for the first growing season and 1.28 to 1.4 kg/m^3 for the second growing season, respectively. The highest value of wheat WUS was obtained at combined fertilizers treatment (CF) and the lowest value obtained at control treatment (IF). The percentage increase values of the wheat WUS relative to control treatment were 13.8, 10.5 & 15.3 % for IF, OF and CF fertilizers treatments during the first growing season and 23.1, 17.7 & 26.2 % for the same treatments during the second growing season, respectively. This trend was almost similar to that obtained at the effect of inorganic and organic fertilizers treatments on wheat grain yield.

The interaction between irrigation frequencies and fertilizers types on water use efficiency values of wheat crop was no significant effect. The results revealed that the irrigation interval every 14 days with combined fertilizers treatment (CF) had the highest wheat WUS value, while irrigation interval every 18 days with organic fertilizer treatment (OF) had the lowest value compared to control treatment (without fertilizers) during studied growing seasons. These results indicated that the wheat crop irrigated by irrigation interval of 14 days with fertilization by combined between inorganic and organic fertilizers increased wheat WUS, while, irrigated by the long irrigation interval of 18 days with separately organic fertilizer decreased WUS values. Consequently, the irrigation interval of wheat plants must be short interval of 14 days with addition combined between inorganic and organic fertilizers to the clay loam soil. The long irrigation interval more than 14 days, the wheat plants might be subjected to water stress. Also, the separately organic fertilizer is insufficient for fertilization requirements of wheat crop during growing season. Moreover, the organic fertilizer could not depress the harmful effect of water stress, then, the grain yield reduced.

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تأثير فترات الري والتسميد على البخر – نتح الفعلي وإنتاجية القمح

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أجريت تجربة حقلية في تربة طميية طينية بمحطة التجارب لمزرعة كلية الزراعة جامعة القاهرة لموسمين متتالين 2010/2011 – 2011/2012 لدراسة تأثير أربعة فترات ري و ثلاثة أنواع من التسميد بالإضافة إلى معاملة المقارنة (بدون تسميد) على البخر – نتح الفعلي ، إنتاج الحبوب و كفاءة استخدام محصول القمح صنف سدس 1 من المياه تحت نظام الري بالخطوط و ظروف منطقة الجيزة. أظهرت النتائج بوضوح أن قيم البخر – نتح الفعلي انخفضت معنويا بزيادة فترات الري خلال موسمي النمو تحت الدراسة. بينما ارتفعت معنوياً قيم البخر – نتح الفعلي بإضافة التسميد المعدني مع التسميد العضوي للتربة. أوضحت النتائج أن ري محصول القمح بفترة ري قصيرة تكون أقل أو تساوي 14 يوماً مع التسميد المعدني والعضوي أدت إلى زيادة البخر – نتح الفعلي الموسمي. بينما ري محصول القمح بفترة ري طويلة 18 يوماً مع التسميد العضوي فقط أدت إلى نقص البخر – نتح الفعلي الموسمي. أظهرت النتائج أن أعطى الري لمحصول القمح كل 10 أيام مع التسميد المعدني والعضوي أعلى قيمة للبخر – نتح الفعلي الموسمي (44,56 سم) بينما أعطى الري كل 18 يوماً أقل قيمة للبخر – نتح الفعلي الموسمي (37,79سم).

أوضحت النتائج أن تأثير فترات الري على محصول الحبوب كان تأثير معنوي خلال موسمي النمو تحت الدراسة، حيث زادت قيم محصول الحبوب بزيادة فترة الري من 10 إلى 14 يوم بينما زيادة فترة الري إلى 18 يوم أدت إلى نقص محصول الحبوب. تراوح متوسط محصول الحبوب للقمح من 2,5 إلى 2,17 و من 2,55 إلى 2,24 طن/فدان لموسم النمو الأول والثاني تحت الدراسة على التوالي . زادت قيم محصول الحبوب للقمح معنويا بإضافة التسميد المعدني والعضوي معا مقارنة بمعاملة المقارنة (بدون تسميد) خلال موسمي النمو تحت الدراسة. زادت قيم محصول الحبوب عند ري القمح بفترة ري قصيرة 14 يوماً مع التسميد المعدني والعضوي بينما أدى ري محصول القمح بفترة ري طويلة أعلى من 14 يوماً أدت إلى نقص محصول الحبوب. عموماً أظهرت النتائج أن زيادة فترة الري أدت إلى زيادة معنوية في كفاءة إستخدام مياه الري خلال موسمي النمو تحت الدراسة. أظهرت النتائج أيضاً أن إضافة التسميد المعدني والعضوي معاً للتربة أدت إلى زيادة كفاءة استخدام مياه الري للقمح مقارنة للمعاملة بدون التسميد (معاملة المقارنة). كان التأثير المشترك لفترات الري وأنواع التسميد على كفاءة إستخدام المياه لمحصول القمح تأثير غير معنوي. زادت قيم كفاءة استخدام مياه الري لمحصول القمح عند الري بفترة ري قصيرة 14 يوماً مع التسميد المعدني والعضوي معاً، بينما نقصت قيم كفاءة مياه الري عند الري بفترة ري طويلة 18 يوماً مع التسميد العضوي فقط. وعلى ذلك يجب أن تكون فترة ري محصول القمح 14 يوماً مع التسميد المعدني والعضوي معاً وذلك في التربة الطميية الطينية وظروف منطقة الجيزة.