J. of Soil Sciences and Agricultural Engineering, Vol. 1 (1): 49 - 64, 2010

EFFECT OF IRRIGATION SCHEDULING AND DIFFERENT NITROGEN LEVELS ON WATER RELATION, YIELD AND YIELD COMPONENTS FOR WHEAT CROP GROWN IN MIDDLE EGYPT (GIZA REGION)

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ABSTRACT

Two field experiments were executed during the two successive seasons of 2005/2006 and 2006/2007at Giza Agricultural Research Station to identify the most effective coefficient of daily pan evaporation accumulation selected from 1.25, 1.00 and 0.75 evaporation pan coefficient (EPC) in scheduling irrigation for wheat, cultivar Sakha 69, receiving 60, 75 and 90 kg N/fed in order to maximize crop and water productivity. The number of applied irrigations and water consumptive use (Cu) were increased as the value of EPC increased and, Cu differed significantly due to nitrogen level, with 90 kg N/fed consuming more water than the other N-levels. The highest Water Use Efficiency (WUE) was recorded under 1.00 EPC comparable to the other tested EPC values and values of WUE, differed due to nitrogen level. The 90 kg N/fed gave the lowest WUE while 75 kg N/fed gave the highest value. The plant height, grain weight/spike, number of spike/m^2 and 1000-grain weight were significantly affected due to the adopted irrigation regimes and generally, tended to increase as EPC increased. Grain and straw yields tended to increase with increasing EPC. The highest values were obtained with 1.25 EPC. All of agronomic yields and yield components were increased with the increase in N- level, as well as with the increase in EPC values. The maximum values of yields and their components were given by 90 kg N/ fed with1.25 EPC.

INTRODUCTION

Wheat is the most important cereal crop used as a major food crop in Egypt, but local production dose not meet the consumption owing to the increased population with limited cultivated area as well as water resources (El-Shaer *et al.* 1997 and Eid *et al.* 1999). Therefore, Egypt would have to find new ways to increase agriculture productivity as an essential national target to fill the gab between production and consumption of wheat. This goal could be achieved by growing more high-yielding cultivars and improving the agronomic factors such as irrigation and fertilizer application.

Irrigation water has to be added timely and sufficiently (with least losses). This is difficult to be achieved in old arable lands in Egypt. One of most efficient irrigation technical methods which does this, is scheduling irrigation using evaporation pan. Moreover mathematical models study to calculate ET0, ET crop and water requirements under Egyptian conditions must be increased to meet the changes in the weather factor affecting water consumption by plant as temperature, rain, solar radiation and sunshine. Early in USA, Jensen and Midleton (1965) carried out studies scheduling crop irrigation via daily records of evaporation pan. In this respect, Abdel-Ghani *et al.* (1994), Shahin and Mosa (1994) stated that exposing wheat crop to high moisture stress was associated with a decrease in seasonal consumptive use. Rayan *et al.* (1999) in Upper Egypt and El-Marsafawy (2000) in Middle Egypt (Giza) used the evaporation pan method to schedule irrigation for wheat via daily accumulative records of class A-pan, to assess water productivity. Pandey *et al.* (2001) studied wheat response to differential seasonal irrigation regimes ranging from 300 to 690 mm applied water for two growing seasons and found that water use increased rather linearly with increased seasonal irrigation. Khalil *et al.* (2005) stated that irrigating wheat at 1.2 evaporation pan coefficient (EPC) in Upper Egypt (Shandaweel) recorded the highest water consumptive uses (Uc) in comparison with 0.8 and 1.0 EPC, with Uc values of 1582, 1797 and 2216 m^3/fed, for irrigation treatments at 0.8, 1.0 and 1.2 EPC, respectively, however 0.8 EPC gave the highest water use efficiency(WUE). Salem *et al.* (2006) in the Delta region of Egypt (Bahteem) reported that Cu and WUE for wheat were highest with 1.2 EPC more than either 0.8 or 1.0 EPC. With respect to crop productivity as a function for soil moisture availability during the growing season, Mohamed and Tammam (1999), Sidrak (2003) and Moussa and Abdel-Maksoud (2004) reported that the number of spikes/m^2, 1000-grain weight, straw and grain yields decreased due to irrigation after higher soil moisture depletion.. El-Marsafawy (2000) and Rayan *et al.* (2000) found that the highest values of grain yield were obtained when wheat crop irrigated at 1.0 evaporation pan coefficient (EPC) compared with 0.6 and 1.4 EPC. El - Sabbagh *et al.* (2002) in Egypt and *Metin* and Attila (2006) in the arid Southeast Anatolia of Turkey, recorded that short irrigation intervals (7. 14 and 21 days) increased plant height, spike length, number of spikes/m^2, number and weight of grain/spike, 1000- grain weight, harvest index and straw and grain yields compared with prolonged irrigation intervals (35 days) .Nitrogen fertilizer is very important for all plants, and it promotes the vegetative growth and increases the protein content in cereals. The imbalances in fertilizer application can reduce fertilizer use efficiency by 20 to 50%, and only a package of agronomic practices will result in the highest effectiveness of fertilizers in food production (FAO, 1980). Singh *et al.* (1996) and Abou-Ahmed (1999) reported that WUE for winter wheat increased with increasing N- application. Angus and Van Herwaarden (2001) stated that seasonal water use of wheat was increased by 23 mm due to providing optimum N fertilizer. Wenlong *et al.* (2004) stated that WUE increased with increasing applied N - fertilizer using four N- levels of Zero, 124, 248 and 372 kg N ha^{-1} for wheat in semi-arid regions. Awad *et al.* (2000), Pandey *et al.* (2001) and Angus and Van Herwaarden (2001) studied wheat response to 5 N levels of 0, 40, 80, 120 and 160 kg N ha^{-1}. Responding of grain yield, spikes m^{-2}, kernels $spike^{-1}$, number of kernel m^{-2} and kernel weight to increases in N levels was positive for both growing seasons particularly at the higher N- rates. Fischer *et al.* (2002) in the sub-humid tropical highlands in the central highlands of Mexico, Lewandowski and Kauter (2003) in South- West, Germany and Iqbal *et al.* (2005) in North-West Pakistan, recorded that applying 60 or 70 kg N ha^{-1} increased grain yield and nitrogen uptake for wheat compared with the zero or 30 kg N ha^{-1}

The main objective of the present trial is to determine the most effective of irrigation regimes (by scheduling irrigation using accumulation evaporation pan coefficient method) under different fertilizer - N levels in order to obtain improved water relation, yield and yield components for wheat, cultivar Sakha 69, under Giza region condition.

MATERIALS AND METHODS

Two field experiments were carried out at Giza Agricultural Research Station, ARC, Giza -Egypt, during 2005/2006 and 2006/2007 growing seasons to study the effect of irrigation scheduling and different applied nitrogen levels on water relation, yield and yield components for wheat grown in middle Egypt. Potential evapotranspiration ET0 was estimated using three ET formulas, i.e. Modified Penman, Penman Monteih and Doorenbos-Pruitt, then compared with actual ET determination by evaporation pan to evaluate the most efficient of these formulas in calculating ET0 for wheat crop grown under Giza region condition in Middle Egypt.

The experiment was laid out in a split - plot factorial design with three replicates. The plot area was 15.0 m^2 (3 x 5 m). The main plots were devoted to irrigation pan coefficient treatments and the sub plots were assigned to the nitrogen level treatments.

The experimental factors and treatments were as follows:

Factor A (Main plots) : irrigation regime (evaporation pan coefficient "EPC"):

I1- 1.25 EPC.
I2- 1.00 EPC.
I3- 0.75 EPC.

Factor B (Sub plots): fertilizer nitrogen levels:

1- 60 kg N/ fed
2- 75 kg N/ fed.
3- 90 kg N / fed.

Sowing dates were 8th Dec., 2004 and 1st Dec., 2005 for the first and second seasons, respectively. Plants were harvested on 6th May 2006 and 2nd May 2007 for each season, respectively. The preceding crop to wheat was sunflower in both seasons.

Irrigation was practiced according to the cumulative values of the daily evaporation records from class A pan established in Giza Agro-climatological Station for the different irrigation treatments. Application of irrigation regime treatments started from the third irrigation. The fertilizer nitrogen was applied in the form of ammonium nitrate (33.5%N) in two equal portions; the first portion was applied immediately before the life irrigation (El-Mohayah irrigation) and the second one after 21 days from the first one. All other practices were applied as adopted in the area and region of the study.

Table (1): Soil moisture constants (% by weight) and bulk density (g/cm^3) of soil of the experimental site at Giza Agricultural Research Station

Depth, cm	Field capacity %	Wilting point %	Available water %	Bulk density(g/cm^3)
00-15	41.85	18.61	23.24	1.15
15-30	33.68	17.50	16.18	1.20
30-45	28.38	16.92	11.46	1.22
45-60	28.05	16.54	11.51	1.28

Weather Data used in calculating actual and potential water consumptive use were collected from Meteorological Giza station during the growing seasons as shown in Table (2).

Table (2): Some meteorological data at Giza Agricultural Research Station, 2005/2006 and 2006/2007 seasons

	2005/2006season							
Month	T max	T min	RH	WS	RF	SS	SR	E pan
Dec.	20.0	7.4	53.0	2.1	1.0	7.0	268	2.3
Jan.	20.4	8.0	57.0	2.0	1.9	7.0	280	2.1
Feb.	22.8	10.0	55.0	2.6	6.0	7.9	354	2.7
Mar.	24.6	10.5	49.0	2.9	6.6	8.6	441	3.4
Apr.	28.7	16.0	48.0	3.3	2.0	9.6	519	4.7
May	32.7	19.6	47.0	3.9	0.0	10.8	585	6.3
	2006/2007 season							
Dec.	23.2	10.1	55.0	2.4	0.6	7.0	268	2.3
Jan.	20,3	7,5	60	2.0	2.4	7.0	280	1,9
Feb.	20,7	7,1	60	2.3	8.0	7.9	354	2,9
Mar.	25,5	10,7	57	3.4	3.1	8.6	441	3,4
Apr.	32,8	17,3	58	4.1	0.0	9.6	519	5.1
May	31,9	16,7	54	3.7	0.0	10.8	585	8,3

T max and T min = maximum and minimum temperatures, °C ; WS = wind speed, m /Sec ; RH = relative humidity % ; RF = rain fall, mm ; SS = actual sun shine, hrs ; SR = solar radiation, cal/cm²/day ; Ep = pan evaporation ,mm/day.

Table (3): Date of different irrigation regimes of the current experiment for the wheat crop grown in Giza region in 2004/2005 and 2005/2006 seasons

Season	Irrigation regime "EPC'	Evapor. (mm)	First Irri.	Secod Irri.	Third Irri.	Fourt h Irri.	Fifth Irri.	Sixth Irri.	Seventh Irri
2005/2006	1.25	82.5	8/12	4/1	3/2	19/2	14/3	29/3	12/4
	1.00	110.0	8/12	4/1	9/2	1/3	23/3	12/4	
	0.75	137.5	8/12	4/1	14/2	6/3	6/4		
2006/2007	1.25	82.5	1/12	28/12	27/1	16/2	7/3	23/3	6/4
	1.00	110.0	1/12	28/12	3/2	26/2	23/3	11/4	
	0.75	137.5	1/12	28/12	9/2	20/3	15/4		

The results were presented and discussed as follow:

A- Water relations:

1- Actual water consumptive use 'CU' (Actual evapotranspiration):

Water consumptive use was determined via soil samples from the sub plots just before each irrigation and 48 hrs later besides at harvest, in 15 cm segments along the 60 cm depth of the soil. The CU was calculated according to Israelsen and Hansen (1962) as follows:

$$CU = D \times Bd \times Q_2 - Q_1 / 100$$

Where:

CU = actual evapotranspiration (i.e., actual consumptive use) (in mm)

D = the irrigation soil depth. (in mm)

Bd = bulk density of soil (g/cm^3).
Q_2 = the percentage of soil moisture two days after irrigation (% w/w).
Q_1 = the percentage of soil moisture before next irrigation (% w/w).

2- Water use effcicincy (WUE):

Water use efficiency in the present work, refers to the amount of wheat grains (kg) produced due to 1 m^3 of water consumed, estimated according to **Vites (1965)** as follows: -

$$WUE = \frac{\text{Grain yield (kg/fed)}}{\text{Seasonal ET } (m^3/\text{fed})}$$

3- Potential evapotranspiration estimated by some ET formulas:

The "WATER" model (Zazueta and Smajstrla, 1984) was used for estimation of potential evapotranspiration by the Modified Penman, Doorenbos- Pruitt methods whereas the CROPWAT 4.3 model was used to estimate potential evapotranspiration by the Penman Monteith method.

B- Growth, yield and some yield attributes:

At harvest, the plants of each entire sub-plot were sampled in order to determine plant height, straw and grain yields. The number of spikes / m^2 was determined by counting all spikes per square meter selected in random from each sub-plot. Ten spikes were randomly taken, from each sub-plot, and weight of grains / spike and 1000-grain weight were determined, then plots were harvested and yields were measured. Data of growth, yield and yield components were subjected to statistical analysis of variance as described by Sendecor and Cochoran (1980).

RESULTS AND DISCUSSION

1. Water relations

1-1 .Actual water consumptive use (Actual evapotranspiration):

Evapotranspiration is the combination of two processes, evaporation and transpiration. Evaporation is direct evaporation of water from the soil surface and/or from the plant surface. Transpiration is the flow of water vapor from the interior of the plant to the atmosphere (Jones *et al.*, 1984).

Results in Table (4) show that seasonal water consumptive use ETa was increased as EPC value increased, since the ETa value under the 1.25 EPC treatment was increased by 10.48 and 25.21 % more than those under 1.00 and 0.75 EPC treatments, respectively in the first season. In the second season, similar trend was observed with increases reached to 10.55 and 21.20%, respectively, for 1.25 EPC treatment compared to1.00 and 0.75 EPC treatments .Two seasons results reveal that, regardless of N- level, water consumptive use was increased as EPC value increased. These results may be attributed to the increase in number of irrigations and to that the soil moisture was more available for extraction by plant roots and as well as soil surface evaporation. These results are in the harmony with those obtained by Moussa and Abdel-Maksoud (2004).

Table (4): Seasonal water consumptive use (mm) of wheat cultivar Sakha69 as affected by irrigation regime and N fertilizer levels at Giza region in 2005 /2006 and 2006/2007 seasons

seasons Irrigation Regime	2005/2006				2006/2007			
	N- levels (kg/ fed)							
	60	75	90	Mean	60	75	90	Mean
	Water consumptive use (mm)							
1.25	317	359	383	353	302	346	423	357
1.00	300	313	336	316	275	315	368	319
0.75	245	268	278	264	265	279	300	281
Mean	287	313	332	309	281	313	364	319

With respect to nitrogen fertilizer levels, seasonal ETa values were 287, 313 and 332 mm for N_1 (60 kg N/ fed), N_2 (75 kg N/ fed) and N_3 (90 kg N/ fed), respectively, for the first season However in the second season, values were 281, 313 and 364 mm for the same N-level treatments. These results indicate that ETa values increased with increasing N- levels. The increased values of ETa with the highest level of N (N_3) were 13.65 and 22.80 % for first and second season, respectively as compared with the lowest level of N (N_1). These results are in a good agreement with those obtained by *Sidrak (2003)* who reported that seasonal water use generally increased with increasing N rate.

1- 2-Water Use Efficiency (WUE):

Values of water use efficiency as recorded in Table (5) indicate that irrigation at 1.00 evaporation pan coefficient gave the maximum water use efficiency of 7.56 kg grains /mm water in 2005/2006 season, while the minimum value was7.23 kg grains /mm water was recorded at 1.25 EPC treatment. In 2006/2007 season the maximum value was 8.03 kg grains /mm resulted from 1.00 EPC treatment, whereas the minimum value was 7.37 kg grains /mm obtained with 1.25 EPC treatment. The two-season results indicate that WUE increased with medium number of irrigation during growing season according to irrigating at medium level of evaporation pan coefficient. These results are in harmony with those reported by EL-Marsafawy (2000) who found that the highest WUE value for wheat was achieved as irrigation practiced according to 1.0 EPC.

Results in Table (5) indicate that the highest value of water use efficiency, 7.80 and 8.00 -kg grain/mm/fed, was obtained with applying 75 kg N/ fed (N2) for both growing seasons. However the lowest one (7.30 and 7.40 -kg grain/mm/fed), was obtained with applying 60kg N/ fed N1. It is clear that both season results reveal that applying 75 kg N/ fed (recommended level) increased WUE to a maximum value compared to 90 kg N/fed (low level) and then declined with increasing N- level up to 90 N/fed. It could be stated that the most effective level of N- fertilizer application with wheat cultivar under study is75kg N/fed (recommended level) at Giza region. This may be due to that N-fertilizer is subjected to be lost by leaching at high levels. In this connection, Ghulam and Al- Jaloud (1995) reported that WUE for winter wheat was increased with increasing N- application.

Table (5): Water use efficiency (kg grain /mm/fed) of wheat cultivar Sakha69 as affected by irrigation regime and N fertilizer levels at Giza region in 2005 /2006 and 2006/2007 seasons.

Season	2005/2006				2006/2007			
Irrigation	N- levels (kg/ fed)							
Regime	60	75	90	Mean	60	75	90	Mean
Water use efficiency (kg grains /mm water								
1.25	6.95	7.38	7.32	7.23	6.99	7.73	7.10	7.37
1.00	7.37	7.46	7.41	7.56	8.4	8.31	7.39	8.03
0.75	6.91	7.94	7.66	7.51	7.28	8.11	7.85	7.75
Mean	7.50	7.80	7.30	7.50	7.80	8.00	7.40	7.72

1.3. Potential evapotranspiration ETo:

Potential evapotranspiration (ETo) throughout wheat growing season duration was estimated from the climatic data of Giza region by Modified Penman, Penman Monteih and Doorenbos - Pruitt. The wheat crop coefficient (Kc) (FAO, 2002), wheat crop evapotranspiration (ETc) values were calculated as follows:

$$Etc = Kc * Eto.$$

Generally, results shown in Table 6 indicate that there were small differences between calculated ETc for the two seasons. This may be due to the variation in the weather conditions. In 2005/2006, seasonal estimated ETc values were 325.0, 351.0 and 403.0, mm for the Modified Penman, Penman Monteih and Doorenbos - Purist, respectively. However the corresponding values were 339.0, 354.0 and 421.0 mm for the same respective formulas in 2005-2006 season.

It is clear that estimated ET varied for the three used formulas and the Doorenbos - Pruitt formula gave the maximum ET crop values in both seasons as compared with others. On the other hand, monthly ETc values of the three formulas started small according to the small plants cover in the early stage, then increased to reach their maximum values in mid season (March) as a result of a complete crop canopy with highest value of crop coefficient (Kc) addition to increase in weather factors value (i.e. temperature, solar radiation and pan evaporation) which calculated formulas are based on, and then tended to decline again until the crop maturity (May) lower Kc. These results may be due to the differences in climatic factors on which calculated formulas are based on. In this concern, Chang (1971) reported that the rate of ET0 depended on evaporation power of the temperature, wind speed, relative humidity and solar radiation. The obtained results are in harmony with those obtained by Sidrak (2003).

Table (6): Crop Coefficient (Kc) and ETo (mm/month) estimated by some ET formulas for wheat at Giza region in 2005/2006 and 2006/2007 seasons

Season		2005/2006						2006/2007					
Month	Kc	Modified Penman		Penman Monteih		Doorenbos-Pruitt		Modified Penman		Penman Monteih		Doorenbos-Pruitt	
		ET0	ETc	ET0	ETc	ET0	ETc	ET0	Etc	ET0	ETc	ET0	ETc
Dece.	0.35	71	25	57	20	63	22	74	26	61	21	60	21
Jan.	0.45	68	31	52	23	62	28	66	30	53	24	68	31
Feb.	0.90	72	65	68	61	104	94	70	63	68	61	104	94
Mar.	1.14	93	106	106	121	115	131	112	128	110	125	121	138
April	0.85	111	94	142	121	145	123	104	88	138	117	153	130
May	0.45	9	4	11	5	12	5	9	4	10	5	18	8
Total		424	325	437	351	502	403	435	339	440	354	524	421

1-4. Comparison of ET crop with the actual ET:

Results of the three mentioned methods and their efficiency in calculating ET crop as compared with actual ET (to select the best one at Giza region for wheat crop under study) are shown in Table 7.

Results of 2005/2006 season reveal that ratios between ET crop and actual ET were 1.03, 1.11 and 1.28 for Modified Penman, Penman Monteith and Doorenbos-Pruitt, respectively. However, in 2006/2007 season, the recorded values were 1.05, 1.10 and 1.30 for the same respective formulas. The overall averages in both seasons were 1.04, 1.10 and 1.29 for the same respective formulas. Results of both seasons reveal that the Modified Penman was the most efficient and relevant in calculating ET crop for wheat in Middle Egypt (i.e., Giza region) as compared with other methods. It is noticed also that the Doorenbos -Pruitt method recorded unsuitable ratio. These results may be due to differences in weather parameter on which each formula is based on for calculating ETo.

Table (7): Comparison between the actual (ETa) and estimated (ETc) for wheat plants grown at Giza region in 2005/2006 and 2006/2007 seasons

Season	2005/2006		2006/2007		Average	
Estimated (ETc)	ET	Ratio	ET	Ratio	ET	Ratio
Modified Penman	325	1,03	339	1,05	332	1,04
Penman Monteith	351	1,11	354	1,10	353	1,10
Doorenbos-Pruitt	403	1,28	421	1,30	412	1,29
Actual (Eta)	316		323		320	

2- Growth, yield and some yield attributes:

2-1. Plant height:

Data in Table (8) reveal that significant effect was found on plant height due to irrigation regime in both seasons of study. The longest plants (89.0 cm in season1and 95.0 cm in season 2), respectively, was obtained under irrigating according to 1.25 pan evaporation coefficient (EPC), while the shortest plants , 77.0 and 80.0 cm were resulted from irrigating at 0.75 EPC treatment, and this was true in the both studied seasons. These results are in agreement with those of Ali (1997) and Hefnawy and Wahba (2003).Data also show that, there are significant differences among nitrogen levels to influence plant height trait in both seasons. The highest values of 87.0 (season1) and 88.0-cm (season2) were obtained with applying 90 kg /N/fed (N3), while the lowest values of 72.0 and 76.0 cm were recorded with N1 treatment. Average plant height was significantly increased by 17.24 and 13.66 % with N3 as compared with N1 for both seasons, respectively. This effect of N may be due to its role in development and elongation of roots thus using water more efficiently. These results are in harmony with those obtained by Sidrak (2003) who found that plant height increased with increasing N- fertilizer application for wheat crop from 50 up to 100 kg N/fed. The interaction between irrigation regimes and nitrogen levels was significant to alter such trait in both seasons, and the tallest plants were obtained form irrigation by according to 1.25 EPC combined with 90 kg /N/fed (N3).

2-2. Grain weight /spike:

The average values of grain weight /spike as recorded in Table (8) indicate that increasing EPC value caused a significant increase in grain weight/ spike. The highest average values of 2.6 (season1) and 2.9 g (season 2) were obtained when plants received irrigation at 1.25 EPC, and the lowest average values of 1.8 and 2.0 g for each season was obtained at 0.75 EPC. This trend may be due to more available soil moisture under high level of EPC (1.25) resulting in increasing water and nutrients uptake and hence enhancing grain weight /spike. These results are in agreement with those obtained by El-Sabbagh *et al.* (2002) and Moussa and Abdel-Maksoud (2004). Regarding N- fertilizer, results show a positive significant effect on grain weight /spike. The highest values of 2.4g (season1) and 2.8 g (season2) were obtained with applying 90 kg N/fed (N3), while the lowest accompanied adding N1 treatment with values of 2.0 g (season1) and 2.2 g (season 2). Averages of grain weight/spike were increased by 16.7 and 21.48 % with N3 as compared with N1 in first and second season, respectively. These results are in agreement with those obtained by Pandey *et al.* (2001).

Table (8): Plant height (cm), grain weight./spike (g) and 1000-grain weight (g) of wheat crop as affected by irrigation regime and N fertilizer levels at Giza region in 2005 /2006 and 2006/2007 seasons

Irrigation regime	N- fertilizer level	Plant height (cm)			Grain weigh /spike(g)			1000-grain weight (g)		
		2005 /2006	2006 /2007	Average	2005 /2006	2006 /2007	Average	2005 /2006	2006 /2007	Average
1.25	60 kg/fed	84.0	88.0	86.0	2.4	2.5	2.5	43.8	47.0	45.4
	75 kg/ fed	90.0	96.0	93.0	2.6	3.0	2.8	46.3	49.8	48.1
	90 kg/fed	93.0	99.0	96.0	2.9	3.3	3.1	47.0	52.1	49.6
	Average	89.0	95.0	92.0	2.6	2.9	2.8	45.7	49.6	47.7
1.00	60 kg/fed	80.0	81.0	80.5	2.1	2.3	2.2	42.6	45.4	44.0
	75 kg/ fed	83.0	85.0	84.0	2.4	2.8	2.6	43.5	47.0	45.3
	90 kg/fed	86.0	89.0	87.5	2.4	2.9	2.7	45.9	47.8	46.9
	Average	83.0	85.0	84.0	2.3	2.7	2.5	44.0	46.7	45.4
0.75	60 kg/fed	72.0	76.0	74.0	1.6	1.9	1.8	35.5	37.6	36.6
	75 kg/ fed	79.0	81.0	80.0	1.8	2.1	2.0	37.7	40.6	39.2
	90 kg/fed	81.0	83.0	82.0	2.0	2.3	2.2	39.6	42.4	41.0
	Average	77.0	80.0	78.5	1.8	2.1	2.0	37.6	40.2	38.9
Average 60kg/fed		79.0	82.0	80.5	2.0	2.2	2.1	40.6	43.3	42.0
Average 75kg/fed		84.0	85.0	84.5	2.3	2.6	2.5	42.5	45.3	43.9
Average 90kg/fed		87.0	88.0	87.5	2.4	2.8	2.6	44.2	47.4	45.8
L.S.D. at 5%										
	Irrigation	1.25	5.40		0.15	0.27		0.93	0.97	
	N- levels	0.88	4.33		0.11	0.16		1.07	1.03	
	Interaction	N. S.	N. S.		N. S.	N. S.		N. S.	N. S.	

2-3. The 1000-grain weight:

As shown in Table (8) the 1000-grain weight was influenced significantly by the irrigation regimes in the two studied seasons. The highest values of 45.7 -g (season1) and 49.6 (season2) resulted under irrigation at 1.25 EPC. Comparable values for 1.00 EPC are 44.0 and 46.7 and 37.6 and 40.2 g for 0.75 EPC in season1 and season2, respectively. These results are in agreement with those obtained by El-Kalla *et al.* (1995) and Moussa and Abdel-Maksoud (2004) who reported that 1000-grain weight tended to decrease as soil moisture availability decreased .The differences in the values of 1000-grain weight among the nitrogen levels were significant in both growing seasons. The highest values of 44.2 (season1) and 47.4 g (season2) were obtained with adding 90 kg N/fed, while the lowest ones of 40.6 and 43.3 were recorded in season1 and season2, respectively with applying 60kg N/fed. Results reveal that increasing nitrogen levels significantly increased the 1000-grain weight values. These results are in harmony with those obtained by Sidrak (2003) who noticed that grain yield components were affected by increasing N rate from 50 to 100 kg N/ fed. No significant interaction effect was found in both seasons. The maximum values, 47.0 and 52.1 g were obtained from the treatment of 1.25 EPC + 90 kg N/fed in the first and second growing season, respectively. The lowest values of 35.5 and 37.6-g were obtained from the treatment of 0.75 EPC + 60kg N/fed for the same respective seasons.

2-4. Number of spike/m^2:

Data in Table (9) show that the adopted irrigation treatments significantly affected the number of spike/m^2 in both seasons. The highest values were 304.0 and 330 spike/m^2 obtained from irrigation at 1.00 evaporation pan coefficient in the first and second season, respectively. However, the lowest values were 237.0 and 271 spike/m^2 obtained from irrigation at 0.75 EPC for the same respective seasons. In respect to both season results, it could be concluded that frequent irrigation caused an increase in number of spike/m2. This might be attributed to positive effect of moderate available moisture at grain filling which increase the starch content and organic compounds in wheat plants. These results agree with those obtained by Rayan *et al.* (2000), Sidrak (2003) and Salem *et al.* (2006). Data also indicate that number of spike/m2was significantly and regularly increased with increasing nitrogen levels. The highest values of 296.0 (season1) and 317.0 spike/m^2 (season2) were obtained with applying N3 treatment, while lowest values of 264.0 (season1) and 298.0 spike/m^2 (season2) were found with N1 treatment. Average number of spike/m^2 was increased by 10.8 and 5.6 % with addition of 90 kg N/ fed (N3) as compared with 60 kg N/fed (N1) for both growing seasons.These results agree with those obtained by Bing and Sheng (2006). The interaction results reveal that none- significant effect was found between different treatments. The maximum values of 318.0 spike/m^2 and 336 spike/m^2 were obtained by 1.25 and 1.00 EPC +90 kg N/ fed for (season 1) and (season2), respectively, while the lowest values of 215.0 spike/m^2 (season 1) and 260.0 spike/m^2 (season2) were gained by 0.75 EPC + 60 kg N/ fed.

2-5. Straw yield:

Data in Table (9) show that irrigation treatments significantly affected straw yield in both seasons. The highest values of 5952 kg/fed (season1) and 6125 kg/fed (season 2) were obtained from irrigating at 1.25 EPC treatment, then tended to decrease as irrigation was scheduled at 1.00 and 0.75 EPC. Increases due to 1.25 over 0.75 EPC were 31.7 and 35.4 % for the same respective seasons. This reflects the effect on growth attributes and number of productive tillers. These finding are similar to those obtained by *Laura et al. (2008)*. Regarding the effect of nitrogen fertilizer levels, results show a significant effect on straw yield with average values of 4884, 5265, and 5497 for N1, N2 and N3, respectively for the first season. Comparable average values for the second season are 5366, 5604, and 6131 for the same respective treatments. The average increases for straw yields of N3 over the yield of N1for both seasons were 11.15 and 12.48 %, respectively. These results are in full agreement with those reported by Sidrak (2003) who found that increasing N level up to 100 kg N/fed increased straw yield of wheat crop. There was significant interaction between irrigation regime and N level; the interaction is shown when the decrease occurred with the decreases in EPC, which was particularly considerable under high N levels.

Table (9): Number of spike/m², straw and grain yield (kg /fed) of wheat crop as affected by irrigation regime and N fertilizer levels at Giza region in 2005 /2006and 2006/2007 seasons

Irrigation regime	N-fertilizer level	Number of spike/m²			grain yield (kg /fed)			straw yield (kg /fed))		
		2005 /2006	2006 /2007	Average	2005 /2006	2006 /2007	Average	2005 /2006	2006 /2007	Average
1.25	60 kg/fed	286.0	314.0	300.0	2202	2111	2157	5471	5876	5674
	75 kg/ fed	305.0	326.0	315.5	2648	2699	2674	5936	6133	6035
	90 kg/fed	318.0	334.0	326.0	2805	2825	2815	6299	6456	6378
	Average	303.0	325.0	311.5	2552	2545	2549	5952	6125	6039
1.00	60 kg/fed	290.0	320.0	305.0	2210	2134	2172	5063	5700	5382
	75 kg/ fed	308.0	334.0	321.0	2335	2402	2369	5414	5908	5661
	90 kg/fed	314.0	336.0	325.0	2489	2483	2486	5576	6632	6104
	Average	304.0	330.0	317.0	2345	2340	2343	5321	6080	5701
0.75	60 kg/fed	215.0	260.0	237.5	1832	1900	1866	4118	4522	4320
	75 kg/ fed	240.0	273.0	256.5	2129	2156	2143	4435	4771	4603
	90 kg/fed	256.0	280.0	268.0	2129	2285	2207	4617	5305	4961
	Average	237.0	271.0	254.0	2030	2114	2072	4390	4866	4628
Average 60kg/fed		264.0	298.0	281.0	2421	2419	2420	4884	5366	5125
Average 75kg/fed		284.0	311.0	297.5	2491	2531	2511	5265	5604	5435
Average 90kg/fed		296.0	317.0	306.5	2342	2333	2338	5497	6131	5814
L.S.D.at 5%	Irrigation	6.19	13.58		85.9	88.38		146.88	71.75	
	N- levels	6.19	9.37		66.21	49.22		108.80	54.97	
	Interac.	N. S.	N. S.		N. S.	N. S.		188.44	95.21	

2-6. Grain yield (kg/ fed):

Results in Table (9) show that the grain yield was significantly influenced due to irrigation regimes in the both growing seasons. Wheat grain yield was higher as the plants were irrigated at 1.25 EPC, which reached to 8.83 and 9.58 % for EPC 1.25 treatment over the 1.00 and 0.75 EPC treatments in increases to the first season. In the second season the 1.25 EPC surpassed the 0.75 EPC by 20.39 %. The superiority of the 1.25 EPC shows that sufficient irrigation increased grain yield of wheat crop. This trend reflects the importance of soil water to increase plant nutrient availability in soil solution and to improve all growth factor and yield components, which lead to increases production of wheat grain yield. On other hand, results may prove that water stress is one of the main environmental factors, which negatively affects yield production by increasing water pressure around plant roots and due to reduction of water and nutrient uptake. These results are in harmony with those obtained by Amin (2003) and Metin Sezen *et al.* (2006) who stated that wheat crop in the arid region for three growing season showed highest average grain yields at the highest irrigation level. Nitrogen level had a significant effect on grain yield as shown in Table 9. Average value was higher as the plants were treated by 75 kg N/fed with small increase of 2.81 and 3.62 % over 60 kg N/fed treatment for season1 and season2. This may be attributed to the utilization of nitrogen at recommended rate for this cultivar. These results are in agreement with those obtained by Awad *et al.* (2000) and Iqbal *et al.* (2005) who noticed that applying 60 kg N ha−1 increased grain yield for wheat grown under semi-arid conditions as compared with 30 kg N ha^{-1}. No significant interaction effect was found in the current study between irrigation regime and nitrogen fertilizer levels in both growing seasons.

In conclusion, under Giza area conditions, it is advisable to use Sakha69 wheat cultivar with irrigation according to 1.00 EPC and treated with 75 kg N / fed since most of growth, yield and yield components traits and water use efficiency were enhanced with such treatments.

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تأثير جدولة الري ومعدلات مختلفة من التسميد النيتروجيني على العلاقات المائية والنمو و المحصول لنباتات القمح النامية تحت ظروف منطقة مصر الوسطي(منطقة الجيزة)

ممدوح محى الدين برعاص ، محمد عبد الوارث محمود و نعمة الله يوسف عثمان
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أقيمت تجربة حقلية بمحطة البحوث الزراعية بالجيزة خلال موسمي ٢٠٠٥/٢٠٠٦ و 2007/2006لدراسة تأثير جدولة ا لرى باستخدام بيانات معامل وعاء البخر (1.25 ,01.0 0.75),ومستويات متزايدة من التسميد النيتروجيني على العلاقات المائية و النمو و المحصول لصنف القمح جيزة ٦٩ . كانت أهم النتائج كما يلي :

١- زاد عدد الريات و كذا الاستهلاك المائي لصنف القمح تحت الدراسة بزيادة قيمة معامل وعاء البخر.كما اختلفت قيمة الاستهلاك المائي معنويا بزيادة مستويات التسميد النيتروجيني حيث سجلت النباتات المسمدة بـــ 90 كجم/ف أعلى القيم للاستهلاك المائي.

٢- انخفضت قيمة كفاءة استخدام مياه الري عند الجدولة بمعامل بخر 1.25واتجهت للزيادة بقيم متدرجة بنقص قيمة المعا مل بينما أظهر مستوى التسميد المتداول 75) كجم/ف (أعلى قيمة لكفاءة استخدام مياه الري).

٣- ازدادت قيم طول النبات وزن حبوب /السنبلة، وزن حبوب /م٢ و وزن الـــ 1000حبة معنويا مع زيادة قيمة معامل وعاء البخر القياسي.

٤- محصول الحبوب للفدان والمحصول البيولوجي اتجهت للزيادة معنويا بزيادة معامل وعاء البخر القياسي حيث سجل الري عند 1.25معامل بخر أعلي القيم وذلك للموسمين.

٥- تأثرت قيم النمو ومكونات المحصول تأثيرا معنويا بمستويات النيتروجين حيث سجلت النتائج أعلي القيم مع التسميد ب ٩٠ كجم نيتروجين /فدان فيما عدا محصول الحبوب حيث سجل أعلى القيم مع التسميد بـــ ٧٥ كجم نيتروجين /فدان مقارنة بالمستوين الآخرين خلال موسمي النمو.

٦- صفات النمو و المحصول و كذا مكوناته لم تأثرت معنويا بتفاعل مستويات الري والتسميد النيتروجيني للصنف تحت الدراسة فى ماعدا المحصول البيولجى حيث سجلت النتائج أعلي القيم من تفاعل 90كجم نيتروجين مع 1.25معامل بخر.

تحت ظروف منطقة الجيزة، ينصح بتسميد محصول القمح صنف جيزة ٦٩ بـــ 75كجم نيتروجين /فدان مع جدولة الري من خلال البيانات اليومية لوعاء البخر القياسي بمعامل قيمته 1.00 وذلك لزيادة المحصول و تحسين كفاءة استخدام مياه الري .

قام بتحكيم البحث

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