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

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ABSTRACT

A field experiment was executed during the two successive seasons of 2004/2005 and 2005/2006 at Giza Agriculture. 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 Giza 168 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, which 90 kg N/fed consuming more water than the other N-levels. The lowest Water Use Efficiency (WUE) was recorded under 1.25 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 obtained the highest value. The plant height, grain weight/spike, grain weight/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 grain yield was obtained with 1.25 EPC and was lower with the other EPC treatments particularly with straw yield. 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

The agricultural sector is the largest user of water in Egypt with its share exceeding 83% of the total demand of water *(Abu Zeid, 1999).* With increasing demands for municipal and industrial uses of water as result of population increase, the share of agricultural sector of water will be steadily decreased. The development of agricultural production of Egypt's economy strongly depends on its ability to conserve and manage its water resources.

Wheat is the most important cereal crop used as a major food crop, 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 enhancing 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 achieve 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, ETcrop 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 Sezen and Attila Yazar (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)* states 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 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 diffrent fertilizer - N levels in order to obtain improved water relation, yield and yield components for wheat cultivar Giza168 under Giza region condition.

MATERIALS AND METHODS

Two field experiments were carried out at Giza Agricultural Research Station, ARC, Egypt, during 2004/2005 and 2005/2006 growing seasons to study the effect of irrigation scheduling and applied nitrogen rate 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 reign conditions 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

2005 and 2nd May 2006 for each seasons respectively. The preceding crop to wheat was sunflower in both seasons.

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
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 Agriculture Research Station in 2004/2005 and 2005/2006 seasons

	2004/2005 season							
Month	T max	T min	RH	WS	RF	SS	SR	E pan
Dec.	20.8	8.4	55.0	1.90	6.0	7.0	268	2.2
Jan.	20.3	6.9	56.0	2.01	2.0	7.0	280	2.0
Feb.	22.8	8.8	55.0	2.49	6.0	7.9	354	2.4
Mar.	23.5	10.7	51.0	2.39	4.0	8.6	441	3.1
Apr.	28.0	13.8	49.0	3.11	8.0	9.6	519	4.6
May	31.9	16.7	48.0	3.92	0.0	10.8	585	6.2
2005/2006 season								
Dec.	23.2	10.1	55.0	2.10	1.0	7.0	268	2.3
Jan.	20.4	8.0	57.0	2.00	1.9	7.0	280	2.1
Feb.	22.8	10.0	55.0	2.60	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

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, hr ; SR = solar radiation, $cal/cm^2/day$; Ep = pan evaporation ,mm/day

Irrigation was practiced according to the cumulative values of the daily evaporation records from class A pan establish 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 (3): Date of different irrigation regimes of the current experiment for the wheat crop grown at Giza region in 2004/2005 and 2005/2006 seasons.

Season	Irrigation regime "EPC"	Evapor. (mm)	First Irri	Secod Irri	Third Irri	Fourth Irri	Fifth Irri	Sixth Irri	Seventh Irri
2004 /2005	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		
2005 /2006	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 11.58 and 31.22 % 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 increased reached to 9.42 and 34.41%, 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 increased number of irrigations and 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 Rayan et al (1999) and Moussa and Abdel-Maksoud (2004)

Table (4): Seasonal water consumptive use (mm) of wheat cultivar Giza168 as affected by irrigation regime and N fertilizer levels at Giza region in 2004 /2005 and 2005/2006 seasons.

Irrigation regime	2004/2005 season				2005/2006 season			
	N- levels (kg/ fed)							
	60	75	90	Mean	60	75	90	Mean
Water consumptive use (mm)								
1.25	354	382	450	395	366	421	468	418
1.00	311	350	401	354	321	385	439	382
0.75	273	305	325	301	300	304	329	311
Mean	313	346	392	350	329	370	412	370

With respect to nitrogen fertilizer levels, seasonal ETa values were 313.0, 346.0 and 392.0 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 second season, values were 329.0, 370.0 and 412.0 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 20.25 and 20.15 % for first and second seasons, respectively as compared with the lowest level of N (N_1). These results are in a good agreement with those obtained by *Abou-Ahmed (1999)* 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 0.75 evaporation pan coefficient gave the maximum water use efficiency of 7.69 kg grains /mm water in 2004/2005 season, while the minimum value was7.25 kg grains /mm was recorded at 1.25 EPC treatment. In 2005/2006 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 decreasing number of irrigation during growing season according to irrigating at low 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.

Table (5): Water use efficiency (kg grain /mm/fed) of wheat cultivar Giza168 as affected by irrigation regime and N fertilizer levels at Giza region in 2004 /2005 and 2005/2006 seasons.

Irrigation regime	2004/2005 season				2005/2006 season			
	N- levels (kg/ fed)							
	60	75	90	Mean	60	75	90	Mean
Water use efficiency (kg grains /mm water)								
1.25	7.25	7.72	6.77	7.25	7.76	7.52	6.82	7.37
1.00	7.27	7.81	7.61	7.56	8.4	8.31	7.39	8.03
0.75	7.84	7.74	7.48	7.69	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

Results in table 5 indicate 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 season. However the lowest one (of 7.30 and 7.40 -kg grain/mm/fed) were 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 60 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 N-fertilizer subject to loss 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.

1-3 Potential evapotranspiration ETp:

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 2004/2005, seasonal estimated ETc values were 337. 0, 342.0 and 392.0 mm for the Modified Penman, Penman Monteih and Doorenbos - Purist, respectively. However the corresponding values were 352.0,373.0 and 429.0, mm for the same respective formulas in 2005-2006 season.

Table (6): Crop Coefficient (Kc) and ETo (mm/month) estimated by some ET formulas for wheat at Giza region in 20012004/2005 and 2005/2006 seasons.

Season		2004/2005						2005/2006					
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.	0.45	48	22	35	16	44	20	71	32	57	26	63	28
Jan.	0.75	66	50	54	40	62	46	68	51	52	39	62	47
Feb.	0.9	67	60	68	61	75	67	72	65	68	61	104	94
Mar.	1.14	90	103	104	118	112	127	93	106	106	121	115	131
April	0.85	110	94	107	91	142	121	111	94	142	121	145	123
May	0.45	17	8	33	15	24	11	9	4	11	5	12	5
Total		399	337	401	342	458	392	424	352	437	373	502	429

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).

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 2004/2005 season reveal that ratios between ET crop and actual ET were 0.98, 0.96, and 1.12 for Penman Monteith, Modified Penman and Doorenbos-Pruitt, respectively. However, in 2005/2006 season, the recorded values were 1.01, 0.95 and 1.16 for the same respective formulas. The overall averages in two seasons were 0.99, 0.96 and 1.14 for the same respective formulas. Results of both seasons reveal that the Penman Monteith and the Modified Penman were the most efficient and relevant in calculating ET crop for wheat in Middle Egypt (i.e. Giza region) due to its close overestimation that only from 1 to 4% as compared with Doorenbos - Pruitt 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 2004/2005 and 2005/2006 seasons.

Season	2004/2005		2005/2006		Average	
Estimated (ETc)	ET	Ratio	ET	Ratio	ET	Ratio
Modified Penman	337	0.96	352	0.95	344	0.96
Penman Monteith	342	0.98	373	1.01	358	0.99
Doorenbos-Pruitt	392	1.12	429	1.16	411	1.14
Actual (Eta)	350		370		360	

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 tallest plants was (94.0 cm season1and 100.0 cm season2), respectively was obtained under irrigating according to 1.25 pan evaporation coefficient (EPC), while the shortest plants were 81.0 and 83.0 cm resulted from irrigating at 0.75 EPC treatment, and this was true in the two seasons of study.. 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 92.0 (season1) and 96.0-cm (season2) were obtained with applying 90 kg /N/fed (N3), while the lowest values of 84.0 and 88.0 cm were recorded with N1 treatment. Average plant height was significantly increased by 8.7 and 8.0 % with N3 as compared with N1 for two season 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 was 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 for irrigated 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 significant increase in grain weight/ spike. The highest average values of 3.0 (season1) and 3.4g (season2) were obtained when plants received irrigation at 1.25 EPC, and the lowest average value of 2.4 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 increased 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 /skip. The highest values of 2.9g (season1) and 3.2 g (season2) were obtained with applying 90 kg N/fed (N3), while the lowest accompanied adding N1 treatment with values of 2.4 g (season1) and 2.6 g (season2). Average of grain weight/spike were increased by 17.2 and 18.8 % 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 grain weight /m^2 (g) of wheat crop as affected by irrigation regime and N fertilizer levels at Giza region in 2004 /2005 and 2005/2006 seasons.

Irrigation Regime	N-fertilizer Level	Plant height (cm)			Grain weig. /spike(g)			Grain weight /m2 (g)		
		2004 /2005	2005 /2006	Average	2004 /2005	2005 /2006	Average	2004 /2005	2005 /2006	Average
1.25	60 kg/fed	89	95	92	2.7	2.9	2.8	669.2	690.0	679.6
	75 kg/ fed	95	100	98	3.0	3.5	3.3	718.5	718.7	718.6
	90 kg/fed	98	105	102	3.3	3.7	3.5	723.4	724.6	724.0
	Average	94	100	97	3.0	3.4	3.2	703.7	711.1	707.4
1.00	60 kg/fed	85	89	87	2.4	2.7	2.6	601.4	671.2	636.3
	75 kg/ fed	87	97	92	2.4	3.2	2.8	630.3	689.2	659.8
	90 kg/fed	92	99	96	3.0	3.3	3.2	639.4	712.3	675.9
	Average	88	95	92	2.7	3.1	2.9	623.7	690.9	657.3
0.75	60 kg/fed	77	81	79	2.2	2.2	2.2	551.2	571.4	561.3
	75 kg/ fed	81	84	83	2.5	2.4	2.5	613.7	603.9	608.8
	90 kg/fed	85	84	85	2.5	2.6	2.6	625.5	622.0	623.8
	Average	81	83	82	2.4	2.4	2.4	596.8	599.1	598.0
Average 60kg/fed		84	88	86	2.4	2.6	2.5	607.3	644.2	625.7
Average 75kg/fed		88	94	91	2.6	3.0	2.8	654.2	670.6	662.4
Average 90kg/fed		92	96	94	2.9	3.2	3.1	662.8	686.3	674.6
L.S.D. at 5%	irrigation	2.67	9.94		0.27	0.10		20.55	12.83	
	N- levels	1.30	6.08		0.16	0.12		19.43	14.71	
	Interaction	2.25	N. S.		N S	0.20		N. S.	N. S.	

Regarding the interaction between irrigation and N-level application on grain weight/spike, there was a significant effect in the second season only. The maximum values of 3.7 and 3.3 g/ spike were obtained from the interaction between 1.25 EPC x 90 kg N /fed in first and second season respectively. However the lowest value of 2.4 g/ spike gained from the interaction between 0.75 EPC x 60 kg N /fed for the same respective seasons.

2-3. Grain weight /m^2 (g):

Data in Table (8) show that the adopted irrigation treatments significantly affected the grain weight/m^2 in the two seasons. The highest values were 703.7 and 711.1 g obtained from irrigation at 1.25 evaporation pan coefficient in the first and second seasons, respectively. However, the lowest values were 596.8 and 599.1 g obtained from irrigation at 0.75 EPC for the same respective seasons. Respect to both season results, it could be concluded that frequent irrigation caused an increase in grain weight/m^2. This might be attributed to positive effect of more 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 grain weight/m^{2}was significantly and regularly increased with increasing nitrogen levels. The highest values of 662.8(season1) and 686.3g (season2) were obtained with applying N3 treatment, while lowest values of 607.3g (season1) and 644.2g (season2) were found with N1 treatment. Average grain weight/m^{2}was increased by 8.4 and 6.1 % with addition of 90 kg N/ fed (N3) as compared with 60kg 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 723.4 g/m^2 (season 1) and 724.6 g/m^2 (season2) were obtained by 1.25 EPC +90 kg N/ fed and the lowest values of 551.2 g/m^2 (season 1) and 571.4 g/m^2 (season2) were gained by 0.75 EPC + 60 kg N/ fed.

2-4. The 1000-grain weight:

As shown in Table 9 the 1000-grain weight was influenced significantly by the irrigation regimes in the two studied seasons. The highest values of 51.6-g (season1) and 52.8g in (season2) resulted under irrigation at 1.25 EPC. Comparable values for 1.00 EPC are 49.2 and 42.5I and 50.5 and 44.1g for 0.0.75 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 the 1000-grain weight tended to decrease as soil moisture availability decreased .The differences in the values of the 1000-grain weight among the nitrogen levels were significant in both growing seasons. The highest values of 50.5(season1) and 51.0g (season2) were obtained with adding 90 kg N/fed, while the lowest ones of 44.0 and 46.9 in season1 and season2, respectively were 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 were 54.5 and 45.3 g obtained from the treatment at 1.25 EPC + 90 kg N/fed in the first and second growing season respectively. The lowest values of 40.6 and 41.6-g were obtained from the treatment at 0.75 EPC + 60kg N/fed for the same respective seasons.

2-5- Straw yield:

Data in Table 9 show that irrigation treatments significantly affected straw yield in both seasons. The highest values of 6320 kg/fed (season1) and 6915 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 5079, 5550, and 6080 for N1, N2 and N3, respectively for the first season. Comparable average values for the second season are 5748, 6111, and 6611 for the same respective treatments. The average increases for straw yields of N2 and N3 over the yield of N1for the two seasons are 7.7 and 17.2 %, 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 decreases which occurred with the decreases in EPC was particularly considerable under conditions of the high N levels.

Table (9): 1000- g rain weight (g) straw and grain yield (kg /fed) of wheat crop as affected by irrigation regime and N fertilizer levels at Giza region in 2004 /2005 and 2005/2006 seasons.

Irrigation regime	N-fertilizer level	1000-grain weight (g)			grain yield (kg /fed)			straw yield (kg /fed))		
		2004 /2005	2005 /2006	Average	2004 /2005	2005 /2006	Average	2004 /2005	2005 /2006	Average
1.25	60 kg/fed	46.6	50.9	48.8	2568	2839	2704	5681	6320	6001
	75 kg/ fed	53.6	53.2	53.4	2950	3166	3058	6400	7112	6756
	90 kg/fed	54.5	54.3	54.4	3048	3194	3121	6879	7312	7096
	Average	51.6	52.8	52.2	2855	3066	2961	6320	6915	6618
1.00	60 kg/fed	44.9	48.2	46.6	2260	2696	2478	5233	6210	5722
	75 kg/ fed	49.6	51.6	50.6	2735	3198	2967	5600	6220	5910
	90 kg/fed	53.1	51.7	52.4	2890	3244	3067	6033	6911	6472
	Average	49.2	50.5	49.9	2628	3046	2837	5622	6447	6035
0.75	60 kg/fed	40.6	41.6	41.1	2140	2185	2163	4324	4714	4519
	75 kg/ fed	43.0	43.8	43.4	2360	2465	2413	4650	5000	4825
	90 kg/fed	43.9	46.9	45.4	2430	2583	2507	5327	5610	5469
	Average	42.5	44.1	43.3	2310	2411	2361	4767	5108	4938
Average 60kg/fed		44.0	46.9	45.5	2323	2573	2448	5079	5748	5414
Average 75kg/fed		48.7	49.5	49.1	2682	2943	2813	5550	6111	5830
Average 90kg/fed		50.5	51.0	50.7	2789	3007	2898	6080	6611	6346
L.S.D. at 5%	Irrigation	10.87	23.86		150.97	155.33		258.14	126.10	
	N- levels	8.91	13.48		95.27	70.81		156.54	79.10	
	Interac.	N.S.	N.S.		N.S.	N.S.		271.14	137.0	

4-2-6. Grain yield (kg/ fed):

The results in Table 9 show that the grain yield was significantly influenced due to irrigation regimes in the two growing seasons. Wheat grain yield was higher as the plants were irrigated at 1.25 EPC with increases which reached to 8.00 and 19.11 % for EPC 1.25 treatment over the 1.00 and 0.75 EPC treatments, respective in the first season. In the second season both 1.25 EPC and 1.00 EPC were very much similar, but 1.25 EPC surpassed the 0.75 EPC by 16.07 %. The superiority of the 1.25 EPC shows that sufficient irrigation increased grain yield for wheat crop. This trend reflects the importance of soil water to increase plant nutrient availability in soil solution and improvement all growth factor and yield component, which lead to increased production of wheat grain yield. On other hand, results may prove that water stress is one of the main environmental factors, which negatively effect 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 90 kg N/fed, with increases of 2.88 and 11.94 % more than those under 75and 60 kg N/fed treatments, for season1 and 4.56 and 15.40 % for season2, for the same respective treatment. This may be attributed to the association of nitrogen supply with vigorous vegetative growth and deep green color, which relate to carbohydrate utilization. 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 a 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 Giza 168 wheat cultivar with irrigation according to 1.00 EPC and treated with 90 or 75 kg N / fed since most of growth, yield and yield components traits and water use efficiency were enhanced with such treatment.

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تأثير جدولة الري باستخدام بيانات وعاء البخر القياسي و إضافات مختلفة من التسميد النيتروجيني على العلاقات المائية والنمو و المحصول لنباتات القمح النامية تحت ظروف منطقة مصر الوسطى

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أقيمت تجربة حقلية بمحطة البحوث الزراعية بالجيزة خلال موسمي 2005/2004 و 2006/2005 لدراسة تأثير جدولة ا لرى باستخدام بيانات معامل وعاء البخر 1.00 - 1.25) (0.75 - ومستويات متزايدة من التسميد النيتروجيني على العلاقات المائية و النمو و المحصول لصنف القمح جيزة .168و كانت أهم النتائج كما يلى:

1- 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 ب 90كجم/ف أعلى القيم للاستهلاك المائي .

2- 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 .

3- ازدادت قيم طول النبات وزن حبوب /السنبلة ,وزن حبوب /م , 2وزن ال 1000 حبة معنويا مع زيادة قيمة معامل وعاء البخر القياسي.

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

5- تأثرت قيم النمو والمحصول ومكونات المحصول تأثيرا معنويا بمستويات النيتروجين حيث سجلت النتائج أعلي القيم مع التسميد ب 90 كجم نيتروجين /فدان مقارنة بالمستوين الآخرين خلال موسمي النمو

6 - صفات النمو و المحصول و كذا مكوناته تأثرت بتفاعل مستويات الري والتسميد النيتروجيني للصنف تحت الدراسة.

تحت ظروف منطقة الجيزة ، ينصح بتسميد محصول القمح صنف جيزة 168 ب 75 كجم 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 .