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Water requirements for some wheat cultivars in north nileNile delta

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ABSTRACT

Two field experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, North Nile Delta region during the two growing seasons (2008/2009 and 2009/2010) to find out the response of some wheat cultivars to different irrigation levels. Four wheat cultivars were subjected to 3 irrigation levels based on: soil moisture depletion (SMD) in the effective root zone, Ibrahim's equation (ET_P = 0.1642 + 0.8 EP) and watering till 5.0 cm above the soil surface. The wheat cultivars were: Sakha 93, Giza 168, Gemmeiza 7 and Gemmeiza 9.

The most important results could be summarized as follows:

The highest mean values of grain yield were recorded from Giza 168 wheat cultivar and the lowest mean values were obtained from Gemmeiza 9. Concerning irrigation treatments, the mean values of wheat grain yield can be descended in order as follows; irrigation till 5.0 cm > Ibrahim's equation > soil moisture depletion (SMD).

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For straw yield, the highest mean values were recorded from Sakha 93 and Gemmeiza 7 with values of 6444.31 and 6486.03 kg/fed., respectively. Regarding irrigation treatments the highest mean values were recorded with Ibrahim's equation and the mean values were 6175.27 and 6161.43 kg/fed. in the first and second growing seasons, respectively.

The mean values for biological yield, the highest mean values were recorded under Giza 168 wheat cultivar in the two growing seasons and with irrigation till 5.0 cm above soil surface.

The mean values of 1000 grain weight can be descended in order as follows: Giza 168 > Sakha 93 > Gemmeiza 7 > Gemmeiza 9 for irrigation treatments, the highest mean values were recorded with irrigation till 5.0 cm above soil surface. Moreover, the highest mean values of harvest index were recorded under Gemmeiza 9 wheat cultivar and under irrigation till 5.0 cm above soil surface.

For water relations, the mean values of water utilization efficiency (W.Ut.E) and water use efficiency (W.U.E.) were obtained from Giza 168 wheat cultivar and irrigation according to soil moisture depletion (SMD). The values of actual waterconsumptive use for all studied cultivars were rather similar but under Gemmeiza 9 the mean values were slightly higher. While, the highest found mean values were under irrigation till 5.0 cm above soil surface.

Values of water applied for the studied wheat cultivars can be descended in order as followsGiza 168 > Gemmeiza 9 > Gemmeiza 7 > Sakha 93. While, for

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irrigation treatments the mean values can be descended in order irrigation till 5.0 cm > SMD > Ibrahim's equation.

INTRODUCTION

Wheat is the main cereal crop in Egypt. Efforts have been executed to minimize the gap between the national consumption and production of wheat. Productivity of wheat is affected by several factors such as water and high yielding cultivars. Effective irrigation management is essential for maximizing the productivity from each unit of applied water. The deficit in wheat production is in the range of 40% of national consumption. Water is one of the most important factors in crop production. The shortage of water in Egypt is continuously increases as a result of its fixed water and the rapid increase in water demand. It is a must to find out the most suitable cultivated wheat cultivar to be chosen in the studied area from irrigation productivity point of view.

In this concern, Metwally *et al.* (1984) revealed that the mean values of seasonal consumptive use by wheat were 40.97, 35.23 and 31.62 cm at Sakha for irrigation at 25, 50 and 75% soil moisture depletion (SMD) from available water. They added that higher yields of grains and straw were obtained with irrigation at 25 and 50% SMD. Sharma *et al.* (1990) reported that water use efficiency of winter wheat was highest under sufficient irrigation conditions compared with stress conditions. Ibrahim and Walker (1993) and Samiha Abou El-Fetouh *et al.* (2008) found that dead level has a higher value of crop-water productivity, in terms of water utilization efficiency (W.Ut.E) in relation to the soil slope. Value of water use efficiency WUE ranged between 0.70-0.82 kg grains/m^3 with an overall average of 0.75 kg grains/m^3 water.

Yousef and Eid (1999) concluded that irrigation at 30% depletion from available soil moisture gave highest WUE of 1.004 and 0.998 kg grains/m^3 water consumed during two successive seasons. Abul-Naas *et al.* (2000) indicated that wheat plants which received 4 irrigations significantly out yielded those which received 1, 2 or 3 irrigations. Khater *et al.* (1997) found that number of spikes/m^2, 1000 grain weight, straw and grain yield decreased with decreasing available soil moisture. Abo Warda (2002) found that at El-Bustan area (Western Nile Delta), irrigation of wheat plants at 458 mm and 333 mm of water increased yield and yield components compared to 208 mm and that WUE progressively decreased with increasing of irrigation.

Hefnawy and Wahba (2003) stated that WUE for wheat increased due to reducing the number of irrigations. Other investigations were done by other researchers such as Singh and Patel (1995). Armstrong *et al.* (1996).

Garabet *et al.* (1998); Reynolds *et al*. (1999) and Nabipour *et al.* (2002) indicating lower yields due to lower irrigation.

The main objective of the current study was to evaluate some wheat-irrigation parameters for some of wheat cultivars which are of a great importance in Egypt.

Specific goals were:

1. To compute irrigation water and the water consumed by wheat,
2. To find out the proper method in computing irrigation water in North Nile Delta region where the study took place and
3. To find out the most suitable cultivar (s) to be grown in the area in connection with maximizing crop-water productivity.

MATERIALS AND METHODS

A field trail was performed at the experimental farm of water requirements and field irrigation research department at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during the two successive growing seasons 2008/2009 and 2009/2010 to study the response of some wheat cultivars to irrigation under conditions of North Middle Nile Delta region. Some soil properties for the studied site were shown in Table (1), where mechanical analysis showed that the soil texture is clay.

Table (1): Some soil characteristics for the studied experimental field.

Soil depth, (cm)	Particle size distribution, %			Texture class	Bulk density g/^{cm3m}	Total porosity %	Field capacity %	PWP %	A.W. %
	Sand	Silt	Clay						
0-15	12.3	33.3	54.4	Clay	1.26	52.45	47.50	25.69	21.81
15-30	20.2	34.2	45.6	Clay	1.30	50.94	39.87	21.66	18.21
30-45	20.4	41.4	38.2	Clay loam	1.29	51.32	38.40	20.86	17.54
45-60	21.1	41.5	37.4	Clay loam	1.38	47.92	36.39	19.78	16.61
Mean	18.5	37.6	43.9		1.31	50.66	40.54	22.00	18.54

Where: P.W.P = Permanent wilting point A.W. = Available water

Mg = mega gram i.e. 10 g

The plot area was 52.5 m^2 (1/80 fed) and the experimental design was a split plot with three replicates involving two factors where main plots were randomly assigned by wheat cultivars and sub main treatments were assigned by irrigation water levels.

I. Main treatments (wheat cultivars):

A. Sakha 93, B. Giza 168, C. Gemmeiza 7 and D. Gemmeiza 9.

II. Sub main treatments (amount of irrigation water).

1. Soil moisture depletion (SMD) direct method,
2. Ibrahim equation (1981) indirect method and
3. Watering till water reaches 5.0 cm above soil surface.

Details of irrigation treatments:

The computation of irrigation water was done as follows:

1. Soil moisture depletion SMD (direct method):

Irrigation water was equaled to the water needed to replenish the soil moisture depleted before each irrigation to field capacityplus 10% as leaching factor.

$$SMD = \frac{F.C - \theta_1}{100} * Db * d * A$$

Where:

SDM = Soil moisture depletion in the effective root zone 60 cm.
F.C. = Soil field capacity %
θ_1 = Soil moisture percentage on weight basis, before irrigation
Db = Soil bulk density g/cm^3
d = Soil wetting depth (effective root zone of 60 cm).
A = Irrigated area

Then irrigation water (IW) was equal to SMD + 10%.

2. Ibrahim's equation (1981) indirect method:

$$ETp = 0.1642 + 0.8\ EP$$

Where:

ETp = Potential evapotranspiration (cm/day)
EP = Pan evaporation (cm/day)

The applied irrigation water (IW) was equaled to crop-evapotranspiration (ETc), which was calculated as follows:

$$ETc = ETp * Kc$$

Where:

Et_c = Water consumed by crop i.e. crop evapotranspiration (cm/day)
Kc = Crop coefficient of wheat during the period of a specific irrigation interval.

3. Watering till the water reaches 5.0 cm above soil surface (control).

Data collected:

1. Irrigation water (IW):

Irrigation water was determined by a constructed rectangular weir in the experimental field with a discharge of 0.01654 m^3/second at 10 cm effective head over the crest.

$$Q = 1.84\ LH^{1.5}-$$

Where Q = Discharge m^3/sec.

2. Actual water consumptive use (CU):

To compute the actual consumed water of the growing plants, soil moisture percentage was determined (on weight basis) before and after each irrigation as well as at harvesting. Soil samples were taken from successive layers of the effective root zone; (0-15, 15-30, 30-45 and 45-60 cm). This method is one of the direct methods of water consumptive use which based on soil moisture depletion (SMD) or so-called actual crop water consumed (ETc) as stated by Hansen *et al.* (1979).

$$CU = \sum_{i=1}^{i=n} \frac{\theta_2 - \theta_1}{100} \times Db_i \times Di$$

Where:

CU = Water consumed (cm) in the effective root zone (60 cm depth),
i = Number of soil layers (1-4),

D_i = Soil layer thickness (15 cm),
Db_i = Soil bulk density (Mg/m^3) of the concerned layer,
θ_1 = Soil moisture percentage before the next irrigation and
θ_2 = Soil moisture percentage, 48 hours after irrigation.

3. Water efficienciesy for crop:

Crop water efficiency was calculated according to Doorenbos and Pruitt (1975), as follows:

$$W.Ut.E. = \frac{Y}{I.W}, \quad W.U.E. = \frac{Y}{CU}$$

Where:

W.Ut.E = Water utilization efficiency (kg/m^3),
W.U.E = Water use efficiency (kg/m^3),
Y = Seasonal yield kg/fed.
I.W = Seasonal irrigation water applied and
C.U = Seasonal crop-water consumed.

Yield parameters:

1. Grain yield (ardab/fed.),
2. Straw yield (kg/fed.).
3. 1000 grain weight (g).
4. Biological yield (grains + straw), kg/fed. and
5. Harvest index.

The obtained data of crop yield was subjected to statistical analysis according to Snedecor and Cochran (1980) and the mean values were compared by L.S.D. at 5% and 1% levels of probability.

RESULTS AND DISCUSSION~~S~~

Grain yield (kg/fed.):

Presented data in Table (2) clearly illustrated that both irrigation treatments and wheat cultivars have a high significant effect on grain yield of the wheat. Concerning wheat cultivars the highest values for grain yield was recorded from Giza 168 in the two growing seasons and the values are 3055.18 and 3170.23 kg/fed. in the first and second growing seasons, respectively. On the contrary, the lowest values were recorded from Gemmeiza 9 and the values are 2606.39 and 2659.04 kg/fed. ~~Generally, the studied wheat cultivars can be descended in order according to its grain yield as follows Giza 168 > Sakha 93 > Gemmeiza 7 > Gemmeiza 9 in the two growing seasons. This might be due to physiological and anatomical characteristics for each variety.~~

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Table (2): Grain yield as affected by irrigation water levels and wheat cultivars in the two growing seasons.

1st growing season

Irrigation levels / Wheat cultivars	Irrigation level: W_1	W_2	W_3	V- mean
Sakha 93	3003.63 a	2830.23 b	2970.47 b	2934.78 b
Giza 168	3022.80 a	2975.73 a	3167.00 a	3055.18 a
Gemmeiza 7	2947.40 a	2844.63 b	2970.57 b	2920.87 b
Gemmeiza 9	2619.40 b	2551.70 c	2648.07 c	2606.39 c
W-mean	2898.31	2800.58	2939.03	

Comparison	LSD 0.05	LSD 0.01
2- W means at each V	100.53	138.50
2- V means at each W	93.37	131.26
2- V means	44.82	67.90
2- W means	50.27	69.25

2nd growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	3113.90 a	2867.20 b	3056.37 b	3012.49
Giza 168	3148.93 a	3030.63 a	3331.13 a	3170.23
Gemmeiza 7	2774.07 b	2734.53 c	2829.43 c	2779.34
Gemmeiza 9	2664.70 c	2602.03 d	2710.40 d	2659.04
W-mean	2925.40	2808.60	2981.83	2905.28

Where:

V = Means of varieties which are Sakha 93, Giza 168, Gemmeiza 7 and Gemmeiza 9

W = Means of irrigation levels which are:

W_1 = Soil moisture depletion (SMD), direct method.

W_2 = Ibrahim equation (1981), indirect method and

W_3 = Watering till irrigation water reaches 5.0 cm above soil surface (control).

Generally, the studied wheat cultivars can be descended in order according to its grain yield as follows Giza 168 > Sakha 93 > Gemmeiza 7 > Gemmeiza 9 in the two growing seasons. This might be due to physiological and anatomical characteristics for each variety.

Regarding irrigation treatments, the highest values of wheat grain yield was recorded under irrigation till 5.0 cm (W_3) above soil surface in the two growing seasons follows by Ibrahim equation (W_2) and finally irrigation according to soil moisture depletion, S.M.D (W_1). Comparing with other treatments which depends mainly upon climatic conditions particularly temperature and solar radiation which are low in winter season. With looking through over the data in the same Table the values of grain yield under treatments of W_2 and W_1 are rather similar. These results are in a great harmony with those obtained by Yousef and Eid (1999) and Samiha Abou El-Fetouh *et al.* (2008).

Straw yield (kg/fed.):

Tabulated data in Table (3) illustrated that wheat straw yield was highly affected by studied wheat cultivars in the two growing seasons where the highest mean values were recorded from Sakha 93 and Gemmeiza 7 and the mean values are 6444.31 and 6486.03 kg/fed. in the first and second

growing seasons, respectively. Increasing the mean values of straw yield under these two cultivars might be due to forming strong and condensed vegetative cover for plants in comparison with the other cultivars and this also might be due to morphological characteristics for each cultivar.

Table (3): Straw yield as affected by irrigation water levels and wheat cultivars in the two growing seasons.

1st growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	6396.23 a	6521.40 a	6415.30 a	6444.31
Giza 168	6384.00 a	6495.17 a	6423.73 a	6434.30
Gemmeiza 7	6330.30 a	6376.00 a	6347.80 a	6351.37
Gemmeiza 9	5345.23 a	5308.53 a	5399.50 a	5351.09
W-mean	6113.94 a	6175.27 a	6146.58 a	6145.27

Comparison	LSD 0.05	LSD 0.01
2- V means at each W	137.44	193.35
2- V means	66.96	101.45

2nd growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	6351.03 b	6511.20 a	6270.27 a	6377.50
Giza 168	6261.33 b	6451.40 a	6397.87 a	6370.20
Gemmeiza 7	6570.07 a	6474.03 a	6414.00 a	6486.03
Gemmeiza 9	5277.37 c	5209.07 b	5348.00 b	5278.14
W-mean	6114.95	6161.43	6107.53	6127.97

Comparison	LSD 5%	LSD 1%
2- W means at each V	161.11	221.96
2- V means at each W	153.92	217.24

Regarding irrigation treatments, there is insignificant effect for irrigation water levels on straw yield for the studied wheat cultivars was observed. The highest mean value was recorded under Ibrahim equation (W_2) and the mean values were 6175.27 and 6161.43 kg/fed. in the first and second growing seasons, respectively. This might be due to this equation was developed particularly for the studied area so, it gave the highest straw yield. These results are in agreement with those obtained by Mahmoud and Ahmad (2005).

Biological yield (kg/fed.):

Biological yield means the sum of the two components of grain and straw yield. Data in Table (4) clearly showed that there is a high significant difference in the mean values of biological yield for the studied wheat cultivars, where the highest mean values were produced from Giza 168 and they were 9489.48 and 9540.41 kg/fed in the two growing seasons, respectively. Concerning irrigation levels failed to find a significant difference between the mean values where the highest value in the first season was recorded under 5.0 cm irrigation depth (W_3) and SMD (W_1) in the second one.

Table (4): Biological yield as affected by irrigation waterlevels and wheat cultivars in the two growing seasons.

1st growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	9399.87 a	9351.63 ab	9385.77 b	9379.09 b
Giza 168	9406.80 a	9470.90 a	9590.73 a	9489.48 a
Gemmeiza 7	9277.70 a	9220.63 b	9318.50 b	9272.28 c
Gemmeiza 9	7964.77 b	7860.23 c	8047.57 c	7957.52 d
W-mean	9012.28	8975.85	9085.64	9024.59

Comparison	LSD 0.05	LSD 0.01
2- W means at each V	162.21	223.48
2- V means at each W	166.03	236.35
2- V means	100.75	152.64
2- W means	81.10	111.74

2nd growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	9464.60 a	9378.40 a	9326.63 a	9389.88
Giza 168	9410.27 a	9481.97 a	9729.00 a	9540.41
Gemmeiza 7	9344.13 a	9228.90 a	8737.47 b	9103.50
Gemmeiza 9	7964.53 a	7941.43 a	7983.57 a	7963.18
W-mean	9045.88 a	9007.67 a	8944.17 a	8999.27

Comparison	LSD 0.05	LSD 0.01
2- V means at each W	492.27	703.33
2- V means	314.31	476.19

1000-grain weight (g):

Presented data in Table (5) clearly showed that the mean values of 1000 grain weight were highly significantly affected by the studied wheat cultivars where the mean values can be descended in order; Giza 168 > Sakha 93 > Gemmeiza 7 > Gemmeiza 9 in the two growing seasons, respectively. This might be due to physiological and anatomical characteristics for each cultivar. It was noticed that the irrigation water levels have a high significant effect on 1000 grain weight in the two growing seasons where the mean values can be descended in order irrigation till 5.0 cm above soil surface (W_3), irrigation according to soil moisture depletion (SMD W_1), and Ibrahim equation (local formula for the studied area (W_2). These results are in a great agreement with those obtained by Abd El-Rahman (2009).

Table (5): 1000 grain weight of wheat cultivars as affected by both irrigation under levels and wheat cultivars in the two growing seasons.

1st growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean

Sakha 93	52.600 b	52.433 a	53.267 b	52.767
Giza 168	53.400 a	52.633 a	53.900 a	53.311
Gemmeiza 7	51.633 c	50.633 b	52.267c	51.511
Gemmeiza 9	51.900 c	49.867 c	51.667 d	51.144
W-mean	52.383	51.392	52.775	52.183

Comparison	LSD 0.05	LSD 0.01
2- W means at each V	0.595	0.820
2- V means at each W	0.532	0.744

2nd growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	51.933 b	51.433 b	52.467 b	51.944 b
Giza 168	52.567 a	51.933 a	53.100 a	52.533 a
Gemmeiza 7	51.167 c	50.033 c	51.567 c	50.922 c
Gemmeiza 9	50.567 d	49.367 d	51.033 d	50.322 d
W-mean	51.558	50.692	52.042	51.431

Comparison	LSD 0.05	LSD 0.01
2- W means at each V	0.420	0.620
2- V means at each W	0.456	0.648
2- V means	0.272	0.412
2- W means	0.255	0.310

Increasing 1000 grain weight for the studied wheat cultivars under irrigation levels till depth 5.0 cm above soil surface comparing with other irrigation treatments might be due to under these conditions, there is enough water a great opportunity for plants to grow well by increasing uptake of nutrients and formed strong plants with good spikes and weight grains. Also, irrigation with this depth during growing seasons make warming for the soil and hence good growth for plants. Data in the same table illustrated that the interaction effect between wheat cultivars and irrigation levels has no stable trend on 1000 grain weight.

Harvest index (%):

Data presented in Table (6) showed that both studied wheat cultivars and irrigation levels have a high significant effect on the mean values of harvest index where the highest mean values were recorded under wheat cultivar Gemmeiza 9 and irrigation level till depth 5.0 cm in the two growing seasons. The highest mean values for Gemmeiza 9 are 32.833 and 33.478% and for irrigation level till depth 5.0 cm are 32.442 and 32.567% in the first and second growing seasons, respectively.

Table (6): Harvest index as affected by irrigation waterlevels and wheat cultivars in the two growing seasons.

1st growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	31.933 b	30.033c	31.667 b	31.211 c
Giza 168	32.133 ab	31.400 b	33.033 a	32.189 b

Gemmeiza 7	31.800 b	30.833 bc	31.867 b	631.500 c
Gemmeiza 9	32.867 a	32.433 a	33.200 a	32.833 a
W-mean	32.183	31.175	32.442	31.933

Comparison	LSD 0.05	LSD 0.01
2- W means at each V	0.916	1.262
2- V means at each W	0.885	1.252
2- V means	0.477	0.723
2- W means	0.458	0.631

2nd growing season

Irrigation levels / Wheat cultivars	Irrigation level W_1	W_2	W_3	V- mean
Sakha 93	32.900 a	30.600 bc	31.833 b	31.778
Giza 168	33.400 a	31.367 b	34.200 a	32.989
Gemmeiza 7	29.733 b	29.667 c	30.633 c	30.011
Gemmeiza 9	33.567 a	33.267 a	33.600 a	33.478
W-mean	32.400	31.225	32.567	32.064

Comparison	LSD 5%	LSD 1%
2- W means at each V	1.061	1.462
2- V means at each W	1.197	1.712

Field and crop water use efficiencies:

Data in Table (7) showed that the mean values of water utilization efficiency (W.Ut.E) were clearly affected by studied wheat cultivars under the same irrigation treatments. The mean values of W.Ut.E can be descended in order; Giza 168 > Sakha 93 > Gemmeiza 7 > Gemmeiza 9. Concerning, the effect of irrigation treatments, generally, the highest mean values were recorded under soil moisture depletion in the two growing seasons. The combination between irrigation according to soil moisture depletion (SMD) and Giza 168 gave the highest mean value.

Concerning water use efficiency (W.U.E), data in Table (8) indicated that the same trend was observed where the highest mean values were found under wheat cultivar Giza 168 and irrigation treatment at soil moisture depletion. These results are in a great harmony with those obtained by Shahin and Mosa (1994) and Abo-Warda (2002) and Abd El-Rahman (2009).

Table (7): Water utilization efficiency for wheat cultivars as affected by irrigation treatments, expressed in kg/m^3.

Water utilization efficiency	Treatments A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3
	Season (2008-2009)											
WUtE kg/m^3	1.81	1.72	1.76	1.80	1.81	1.84	1.80	1.73	1.76	1.63	1.55	1.56
	Season (2009-2010)											
WUtE kg/m^3	1.96	1.83	1.83	1.93	1.94	1.89	1.67	1.63	1.69	1.58	1.66	1.56
	Mean of 2 seasons											

WUtE kg/m^3	1.89	1.78	1.80	1.897	1.88	1.87	1.74	1.68	1.73	1.61	1.61	1.56

Table (8): Water use efficiency for wheat cultivars as affected by irrigation treatments(kg/m^3).

Water use efficiency	Treatments											
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3
	Season (2008-2009)											
W.U.E. kg/m^3	1.89	1.77	1.81	1.89	1.91	1.90	1.89	1.77	1.86	1.72	1.65	1.60
	Season (2009-2010)											
W.U.E. kg/m^3	2.05	1.83	1.91	2.07	2.00	1.99	1.79	1.80	1.68	1.66	1.63	1.69
	Mean of 2 seasons											
W.U.E. kg/m^3	1.97	1.80	1.86	1.98	1.96	1.95	1.89	1.79	1.77	1.69	1.64	1.65

Seasonal consumptive use (Cu):

Presented data in Table (9) showed that the mean values of seasonal consumptive use in the two growing seasons were not greatly affected by wheat studiedcultivars under study where the differences among studied wheat cultivars were slight or so-called the mean values were rather similar. The mean values are 37.83, 37.82, 37.81 and 37.77 cm for Gemmeiza 9, Giza 168, Sakha 93 and Gemmeiza 7.

The highest mean values were recorded under irrigation till 5.0 cm followed by Ibrahim equation and finally irrigation according to soil moisture depletion (SMD). These results are in a great harmony with those obtained by Abd El-Rahman (2009).

Table (9): Seasonal water consumptive use (CU) for wheat cultivars of and as affected ´by irrigation treatments.

CU	Treatments											
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3
	Season (2008-2009)											
CU; cm	38.33	38.01	39.11	38.05	37.13	39.77	37.15	38.18	38.09	36.17	36.91	39.5
	Season (2009-2010)											
CU; cm	36.11	37.15	38.15	36.19	36.00	39.77	36.91	36.12	40.15	38.11	38.10	38.18
	Mean of 2 seasons											
CU; cm	37.22	37.58	38.63	37.12	36.57	39.77	37.03	37.15	39.12	37.14	37.51	38.84

Applied irrigation water (I.W):

Applied irrigation water consists of two components, irrigation water (I.W) and rainfall (RF) as described in Table (10). The mean value for seasonal rainfall in the two growing seasons is 152.9 m^3/fed. or 3.64 cm/fed. presented data in the same Table showed that the mean values of applied

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irrigation water were affected by studied wheat cultivars, where the values of applied water in the two growing seasons can be descended in order as follows Giza 168 > Gemmeiza 9 > Gemmeiza 7 > Sakha 93 and the values are 1667.99, 1657.12, 1647.02 and 1637.16 m^3/fed., respectively.

Table (10): Seasonal water applied (I.W) for some wheat varieties as affected by irrigation.

Water applied	Treatments											
	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_2	D_3
	Season (2008-2009)											
IW. m^3/fed.	1663.9	1644.3	1690.4	1681.5	1644.3	1721.4	1633.9	1644.3	1690.5	1611.2	1644.3	1700.5
IW. cm/fed.	39.62	39.15	40.25	40.04	39.15	40.99	38.90	39.15	40.25	38.36	39.15	40.49
Rf m^3/fed.	142.8											
RF cm/fed.	3.4											
	Season (2009-2010)											
IW. m^3/fed.	1591.2	1563.24	1669.8	1632.3	1563.24	1765.2	1663.1	1563.24	1677.1	1688.2	1563.24	1735.3
IW. cm/fed.	37.89	37.22	39.76	38.86	37.22	42.03	39.60	37.22	39.93	40.20	37.22	41.32
Rf m^3/fed.	294											
RF cm/fed.	162.96											
	3.88											
IW. m^3/fed.	1627.6	1603.77	1680.1	1656.9	1603.77	1743.3	1648.5	1603.77	1688.8	1649.7	1603.77	1717.9
IW. cm/fed.	38.75	38.18	40.00	39.45	38.18	41.51	39.25	38.18	40.21	39.28	38.18	40.90
Rf m^3/fed.	152.9											
RF cm/fed.	3.64											

Means of each variety under the seam irrigation treatments

Concerning the effect of irrigation treatments, the values of applied water were affected by studied irrigation treatments and the values can be descended in order irrigation till depth 5.0 cm > irrigation according to soil moisture depletion (SDM) > irrigation according to Ibrahim equation in the two growing seasons. These results are in agreement with those obtained by Khater *et al.* (1997) and Sidrak (2003) and Samiha *et al.* (2008).

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الاحتياجات المائية لبعض أصناف القمح فى منطقة دلتا النيل

ماهر محمد كساب ، السيد أبو الفتوح مرسى و محمد عبد الفتاح محمد إبراهيم
معهد بحوث الأراضى والمياه والبيئة - مركز البحوث الزراعية - جيزة

الملخص

أجريت تجربتين حقليتين بمحطة البحوث الزراعية بسخا بمحافظة كفرالشيخ بمنطقة شمال دلتا النيل خلال موسمى النمو ٢٠٠٨/٢٠٠٩ ، ٢٠٠٩/٢٠١٠ وذلك بهدف دراسة استجابة بعض أصناف القمح بمستويات مختلفة من ماء الرى. أستخدم من هذه الدراسة أربعة أصناف من القمح خضعت للدراسة وثلاثة مستويات من الرى هى:

١- الرى حسب الإستنفاذ الرطوبى من منطقة الجذور الفعالة.
٢- الرى حسب معادلة إبراهيم وهى $ET_P = 0.1642 + 0.8\ E_P$
٣- الرى حتى عمق ٥سم فوق مستوى سطح التربة. أصناف القمح كانت سخا ٩٣ ، جيزه ١٦٨ ، جميزه ٧ ، جميزه ٩.

ويمكن تلخيص النتائج فيما يلى:

- بالنسبه لمحصول الحبوب سجلت أعلى القيم من الصنف جيزه ١٦٨ لكن أقلها سجلت من الصنف جميزه ٩. وأيضا معاملات الرى كان لها تأثير ملحوظ ويمكن وضعها فى هذه الرتبة.
- الرى حتى عمق ٥سم > معادلة إبراهيم > الاستنفاذ الرطوبى.
- بالنسبه لمحصول القش سجلت أعلى المتوسطات بالنسبه للأصناف كانت من الصنف سخا ٩٣ وجميزه ٧ حيث كانت متوسطات القيم ٦٤٤٤.٣١ ، ٦٤٨٦.٠٣ كجم/فدان أما لمعاملات الرى سجلت أعلى المتوسطات باستخدام معادلة إبراهيم فى الرى حيث كانتكانت متوسطات القيم ٦١٧٥.٢٧ ، ٦١٦١.٤٣ كجم/فدان فى الموسم الأول والموسم الثانى على الترتيب.
- متوسطات القيم بالنسبه لمحصول الحبوب والقش سجلت من الصنف جيزه ١٦٨ فى موسمى الدراسة مع معاملة الرى ٥سم فوق مستوى سطح التربة.
- متوسطات القيم بالنسبه لوزن ١٠٠٠ حبة يمكن ترتيبها تنازليا كالأتى: جيزه ١٦٨ > سخا ٩٣ > جميزه ٧ > جميزه ٩. بالنسبه لمعاملات الرى سجلت أعلى القيم مع الرى ٥سم فوق مستوى سطح التربة. ولكن بالنسبه لدليل الحصاد سجلت أعلى القيم مع الصنف جميزه ٩ ومعاملة الرى ٥سم فوق مستوى سطح التربة.
- كان أعلى القيم بالنسبه لكفاءة استخدام واستغلال المياه سجلت من الصنف جيزه ١٦٨ والرى حسب الاستنفاذ الرطوبى بالنسبه لقيم الاستهلاك المائى من الأصناف المدروسة كانت النتائج إلى حد ما متشابهة لكن الصنف جميزه ٩ كانت قيم الاستهلاك المائى له أعلى قليلا لكن بالنسبه لتأثير معاملات الرى كانت أفضل معاملة الرى بعمق ٥سم فوق مستوى سطح التربة.
- قيم الماء المضاف لأصناف القمح المدروسة يمكن ترتيبها تنازليا كما يلى: جيزه ١٦٨ > جميزه ٩ > جميزه ٧ > سخا ٩٣. بالنسبه لمعاملات الرى فإن متوسطات القيم يمكن ترتيبها تنازليا كالتالى: الرى بعمق ٥سم > الرى حسب الاستنفاذ الرطوبى > معادلة إبراهيم

قام بتحكيم البحث

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