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Yield and Some Water Relation of wheat (*Triticum aestivum* L.) Crop as Influenced by Irrigation Regime, Nitrogen Fertilization Rates and Dosses at North Nile Delta.

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ABSTRACT

Two field experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during the two successive seasons of 2014/2015 and 2015/2016. The objectives of this research were: (i) to study the effect of irrigation regime using tow irrigation levels (40% and 60%) of soil moisture depletion on wheat grain yield; (ii) to evaluate the growth, yield and N use efficiency of wheat as affected by different rates of N fertilization. The experimental used design was split split plot design with three replicates. Irrigation regimes I_1 (irrigated at 40% depletion) and I_2 irrigated at 60% depletion were assigned in the main plots. Three nitrogen rates i.e. zero, 50, and 75 kg N fed^{-1} in the sub plots namely N_0, N_{50}, and N_{75} and two doses of nitrogen i.e D_1 one time and D_2 tow times Results showed that irrigation at 40% depletion significantly increased grain yield by 6.03, 5.5% and straw yield by 7.8, 9.1% compared to irrigation at 60% depletion during the tow growing seasons respectively. The highest grain yield value of 3107.43, 2955.50 kg fed^{-1} was obtained with $I_1N_{75}D_2$ treatment, while the lowest one was 2265.05, 2174.05 kg fed^{-1} with $I_2N_{50}D_1$ in the 1st and 2nd seasons respectively. Also irrigation at 40% depletion resulted in the higher amount of irrigation water to be 1810, 1920 m^3 fed^{-1} distributed on 5 irrigations while it was 1460, 1600 m^3 fed^{-1} irrigated at 60% depletion distributed on 4 irrigations during the 1st and 2nd seasons respectively. The highest consumptive water use was obtained under irrigation at 40% depletion i.e 38.53, 39.6 cm while the lowest 32.48, 32.58 cm obtained from irrigation at 60% depletion in the 1st and 2nd seasons respectively. Increasing nitrogen rates up to 75 kg N fed^{-1} (N_{75}) significantly increased grain yield by 234.4%, 119.0% and 218.5%, 111.2 % as compared to control N_0; N_{50} treatments in the 1st and 2nd seasons respectively. Also, increased straw yield by 192.9%, 111.4% and 182.4%, 111.6% as compared to N_0; N_{50} treatments in the 1st and 2nd seasons respectively. Nitrogen use efficiency (NUE) increased with increasing water applied. It was 0, 42.07, 24.23 and 0, 31.74, 17.32 for N_0, N_{50} and N_{75} on the 1st and 2nd seasons respectively, results showed that increasing the applied N-rate decrease the NUE since the highest value was obtained with N_{50} and the lowest one obtained with N_{75}. The highest water productivity (WP) of 2.20, 2.4 kg m^{-3} was obtained with $I_2N_{75}D_2$ treatment during 1st and 2nd seasons respectively. Therefore, it could be recommended that irrigate wheat at 60% depletion in north Nile Delta soils to save water of about 320 m^3

Keywords: Irrigation regime, Nitrogen use efficiency, water consumptive use, wheat yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is considering the most important cereal crops in Egypt as well as all over the world. Wheat is used mainly as a human food and its straw also is useful as a livestock feed. Wheat yield and yield component are affected by different factors such as climatic conditions, irrigation and soil fertility. Irrigation and fertilization and their interaction are considered one of the most important factors for increasing production (Shaaban, 2006).

Khila *et al*. (2013) stated that the lowest wheat grain yield value was obtained in the soil that had low total available soil water in the root zone as a consequence of a frequent water stress occurring during the reproductive stage of wheat. The highest WUE values were obtained when irrigation was arranged at 25% of the total available soil water in the root zone depletion.

Bazzaz *et al*. (2014) demonstrated that water shortage condition i.e. water administrations which were; non-stress (four water systems were connected at crown root start, booting, anthesis and grain filling stages), and water pressure (water system was halted after crown root start organize i.e. 20 days subsequent to sowing and the yield was shielded from precipitation by rainout protect) caused a general diminishment in morphological and phonological qualities of wheat genotypes. Kahlown *et al*. (2005) reported that wheat plant took its water requirement when water table level kept at a depth of 0.5 m.

On the other hand, nitrogen is one of the most limiting nutrients in cereal crops production, which affected the amount of protein, chlorophyll; protoplasm consequently increases cell size, leaf area and photosynthetic activity. So, it must be used nitrogen fertilizers to most fields in order to enhance cereal yield. While, over application of nitrogen fertilizers can lead to cereal lodging and increased disease pressure which reflected to yield decreases by increasing production cost and yield losses. Cereal crops are very responsive to nitrogen fertilization (Chen *et al.,* 2006). Thus, increasing wheat productivity and quality is also depending on the suitable application of nitrogen fertilizer level.

The time of nitrogen fertilizer application is critical management decisions because it can influence the nitrogen fertilizer uptake efficiency, which is highly correlated with wheat yields (Weisz *et al*., 2001).

Therefore, this investigation was established to determine the effect water regime and nitrogen fertilization rates and doses on wheat Misr 1 grain and straw yield under conditions of Sakha district, Kafr El-Sheikh Governorate circumstances of a middle northern part of the Nile Delta, Egypt.

MATERIALS AND METHODS

Two field trials were carried out during two successive growing seasons (2014/2015 and 2015/2016) at Sakha Agricultural Research Station, Kafr EL-Shiekh Governorate. The site allocated at 31-07' N Latitude, 30-57' E Longitude with an elevation of about 6 meters above mean sea level. Agro-meteorological data of Sakha station, during the two season of study, are presented in Table (1). The experimental design of used treatments was split split plot design with three replicates. Irrigation regimes I_1(irrigated at 40% depletion)and I_2 (irrigated at 60% depletion) were assigned in the main plots , three nitrogen rates i.e. zero,50, and 75 kg N fed.$^{-1}$ in the sub plots namely N_0,

N_{50}, and N_{75} and tow doses of nitrogen i.e. D_1(one time) and D_2 (two times).

The plot area was 52.5 m^2. Plots isolated by ditches of 1.5 m in width to avoid lateral movement of water. Wheat Seeds, Misr1 cultivar were used in the experiments. Wheat grains were sown at the rate of 60 kg seeds fed^{-1}(feddan =0.42 hectare) on 20^{th} and 25^{th} November in the first and second seasons, respectively. The common agricultural practices for growing wheat were arranged according to the recommendations of Ministry of Agriculture except the factors under study.

The soil of the experimental site was clayey texture. The electrical conductivity of soil (ECe) and the irrigation water (ECw), as well as soil pH values were 2.03dSm^{-1},0.48 dSm^{-1} and 8.10 respectively, determined according to, Page (1982). Water table level ranged from 55 t0 95 cm as recorded by observation well. Wheat crop was harvested after 145 days from sowing during both seasons.

Table 1. Sakha agro-meteorological data during 2014/2015 and 2015/2016 seasons.

Seasons	Months	Air temperature (^oC)			Relative humidity (%)			Wind speed	Pan Evap.,	Rain
		Max.	Min.	Mean	Max.	Min.	Mean	m s^{-1}	mm/ day	mm/month
2014/2015	Nov	24.30	13.79	19.05	87.80	60.50	74.15	0.78	2.77	24.60
	Dec.	22.27	9.72	16.00	88.60	63.50	76.05	0.53	1.72	5.70
	Jan.	18.79	6.46	12.63	88.10	61.10	74.60	0.82	2.70	52.55
	Feb.	19.01	7.65	13.33	86.80	62.70	74.75	0.84	2.90	38.80
	Mar.	22.69	11.69	17.19	82.36	58.82	70.59	1.01	3.23	15.25
	Apr .	25.64	13.70	19.67	78.30	48.50	63.40	1.11	6.07	35.85
	May	30.19	18.79	24.49	77.30	46.10	61.70	1.33	7.15	0.00
2015/2016	Nov	24.40	14.42	19.41	87.00	64.20	75.60	0.81	3.18	5.20
	Dec.	19.70	8.30	14.00	88.60	67.20	77.90	0.67	2.50	25.00
	Jan.	13.40	6.35	9.88	85.60	62.50	74.05	0.80	2.52	46.81
	Feb.	22.58	9.35	15.97	85.00	53.10	69.05	0.68	2.51	0.00
	Mar.	24.50	11.60	18.05	81.50	58.30	69.90	0.73	3.59	9.60
	Apr .	30.03	18.62	24.33	81.60	41.80	61.70	1.00	5.93	0.00
	May	30.40	22.80	26.60	71.00	45.80	58.40	0.91	6.47	0.00

*** Source: Meteorological Station at Sakha**

Seasonal water applied (Wa):

Seasonal water applied (mm) was calculated as described by Giriappa (1983);

$$\mathbf{Wa = IW + ER + S}$$

Where:

IW is referring to the irrigation applied, mm

ER refers to the effective rain fall, mm and

S is referring to the contribution of the ground water table to crop water use.

Irrigation management:

Scheduling was depending on the percentage depletion of available soil water in the root zone. The available soil water was determined as the difference between permanent wilting point and water storage at field capacity in the root zone. The maximum allowable depletion (MAD) values of the available soil water were fixed at 40 and 60%. The soil moisture measured by gravimetric measurement and the percentage depletion of available soil water in the effective root zone was estimated by the equation (Martin *et al*., 1990).

Fluctuation of ground water table:

To evaluating and recording water table fluctuation during wheat plant growing seasons, six observations for wells were setup along different treatments. Daily reading of ground water table was recorded by the aid of a metallic sounder that fixed in a sealed tape.

Soil moisture monitoring:

Soil samples were taken from four layers (15 cm each) for each treatment at sowing, before each irrigation, 2 days after irrigation or rainfall, and at the time of harvesting. Data obtained for moisture percentage as above for each depth were used for calculation the soil moisture depletion (SMD), Hansen *et al.* (1980), as follows;

$$\mathbf{SMD= Cu=} \sum_{i=1}^{I=4} D_1 \times D_{b1} \times \frac{PW_2 - PW_1}{100}$$

Where;

CU= Water consumptive use in the effective root zone (60 cm), cm,

D_1 = Soil layer depth (15 cm each).

D_{b1} = Soil bulk density, (Mg m^{-3}) for this depth.

PW_1 = Soil moisture percentage before irrigation (on mass basis, %).

PW_2 = Soil moisture percentage, 48 hours after irrigation (on mass basis, %).

I = Number of soil layers

Crop evapotranspiration (ETc):

Crop evapotranspiration (ETc) or crop consumptive use (CU) was calculated directly from the soil moisture depletion in the effective root zone.

ETc was also computed by the indirect method according to Doorenbos *et al*. (1979) as follows:

$$\mathbf{ET_c = ET_0 \times K_c}$$

Where:

ET_c= Crop evapotranspiration, mm

ET_0= reference crop evapotranspiration mm, and

K_c = crop coefficient.

Contribution of the ground water table (s);

Water movement by capillary rise from water table into active plant root zone is recognized as an important supplementary water resource for irrigation. The contribution of ground water as percentage of the consumptive use was done as follows, (Ibrahim *et al*., 1995)

$$\mathbf{S\ \% = \{ (ETc - SMD) / ETc \} \times 100}$$

Where;

Etc = crop evapotranspiration and

SMD = soil moisture depletion

Growth characters, yield and its components

At harvest stage (145 days from sowing) ten guarded plants were chosen from each sub sub-plot to determine the following characters: Plant height (cm) and number of tillers/plant. Also at harvesting, one square meter was randomly selected from each sub sub – plot to estimate the following characters, grain yield (kg fed^{-1}) and straw yield (kg fed^{-1}).

Water productivity (WP)and Productivity of irrigation water (PIW):

Water productivity (WP) and productivity of irrigation water (PIW) were calculated according to (Ali *et al.,* 2007).

WP = GY/ET

Where

WP (kg/m^3), GY is grain yield ($kg\ fed^{-1}$).

ET total water consumption of the growing season ($m^3/fed.$)

PIW= GY/I

Nitrogen use efficiency (NUE)

$$N\ use\ efficiency = \frac{grain\ yield\ from\ fertilized\ -\ grain\ yield\ from\ control}{fertilizer\ N\ application}$$

Statistical analysis:

The acquired information was factually broke down by investigation of change. The information of the two seasons showed about a similar pattern, Thus, the consolidated examination was finished by Gomez and Gomez (1984). Methods for the treatment were thought about by the minimum critical contrast (LSD) at 5% level of importance which created by Waller and Duncan (1969)

RESULTS AND DISCUSSION

Irrigation water (IW):.

Data as shown in Table (2) and Fig (1) illustrated that the total number of irrigation events were 5 and 4 for I_1 and I_2 respectively, including sowing irrigation. Irrigation water mean values were 1810 and 1460 $m^3\ fed^{-1}$ for I_1 and I_2 respectively in the 1st season and it was 1910 and 1600 $m^3\ fed^{-1}$ in the 2nd season. Irrigation water for I_2 treatment was less than the amount for I_1 treatment. These results indicated that irrigation after 60 % depletion (I_2 irrigation treatment) saved water by about 350 m^3 and 310 m^3 in the first and second season respectively compared with irrigation treatment I_1

The irrigation dates, intervals and amount of irrigation water for the different irrigation regime schemes are reported in Table (2) and illustrated in Fig (1). The minimum seasonal water applied was recorded for I_2 in both seasons and accounted 21.7% less than water applied on average for the two seasons as compared with the I_1 treatment.

Rain fall:

Wheat as a winter crop received rainfall of 172.7 mm ×4.2 = 725.34 m^3 in the first season and 86.61 mm × 4.2= 363.76 m^3 in the second season Table (1).

Soil moisture depletion (S.M.D)

Soil moisture depletion was determined directly the effective root zone. Values of seasonal S.M.D in cm are presented in Table (3) for wheat during the growing seasons 2014/2015and 2015/2016.The obtained data showed that the seasonal S.M.D values were greatly influenced by a number of irrigations, where S.M.D values reduced with increasing the irrigation intervals. S.M.D seasonal values were, 38.52, 32.48 and 39.63, 27.25 cm for the treatments I_1, I_2, during 1st and 2nd seasons respectively. Results in Table (3) showed that, values of the S.M.D were higher under I_1 than that under another one.

Table 2. Date of irrigation, irrigation interval and amount of irrigation water (IW) under the tow irrigation regime for 2014/2015 and 2015/2016seasons respectively

	I_1 Irrigation at 40% depletion			I_2 Irrigation at 60% depletion		
	Date of irrigation	**Irrigation interval(days)**	**IW m^3f^{-1}**	**Date of irrigation**	**Irrigation interval(days)**	**IW m^3f^{-1}**
1st season	20/11	Sowing	400	20/11	sowing	400
	25/12	35	325	5/1	45	350
	5/2	40	385	20/2	45	330
	10/3	25	345	3/4	38	380
	5/4	20	3355			
	17/4	Harvesting		17/4		
	5		1810	4		1460
2nd season	25/11	Sowing	420	25/11	sowing	420
	25/12	30	345	8/1	43	390
	25/1	30	405	20/2	42	400
	25/2	30	365	20/3	28	390
	25/3	28	375			
	5		1910	4		1600

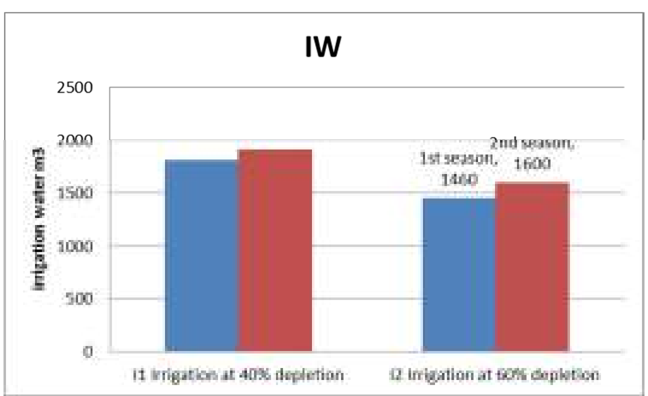

Fig.1. Effect of irrigation regime on irrigation water ($m^3\ fed^{-1}$).

Table 3. number of irrigation, crop evapotranspiration (ETc), soil moisture depletion (SMD) and ETc – SMD= S (contribution of water table) during seasons 2014/2015 and 2015/2016.

Irrigation Depletion	Fertilization Doses	Fertilization Rate	Season 2014/2015 No.of irrig.	ETc (cm)	SMD (cm)	ETc – SMD=S	Season 2015/2016 No.of irrig.	ETc (cm)	SMD (cm)	ETc – SMD=S
		N_0	5	40.6	38.84	1.76	5	42.3	39.61	2.69
	D_1	N_{50}	5	40.6	38.53	2.07	5	42.3	39.66	2.64
I_1		N_{75}	5	40.6	38.05	2.55	5	42.3	39.66	2.64
40%		N_0	5	40.6	38.74	1.86	5	42.3	39.63	2.67
	D_2	N_{50}	5	40.6	38.48	2.12	5	42.3	39.61	2.69
		N_{75}	5	40.6	38.53	2.07	5	42.3	39.61	2.69
		N_0	4	40.6	32.24	8.36	4	42.3	32.90	9.4
	D_1	N_{50}	4	40.6	32.5	8.1	4	42.3	32.66	9.64
I_2		N_{75}	4	40.6	32.15	8.45	4	42.3	32.70	9.6
60%		N_0	4	40.6	32.98	7.62	4	42.3	32.56	9.74
	D_2	N_{50}	4	40.6	32.74	7.86	4	42.3	32.06	10.24
		N_{75}	4	40.6	32.27	8.33	4	42.3	32.59	9.71

Fluctuation of water table depth during the growing season:

Table (4) showed the seasonal averages of water table depth values, for each observation well, under each treatment, during the two seasons. The obtained data reveals that the depth of water table reached to the lowest value immediately before irrigation. While the maximum water depth reached at 2 days after irrigation. Maximum values of water table depth varied between 70.0 cm and 69.0 cm in the 1st and 2nd growing seasons respectively. The corresponding values of the minimum water table depth were 88.0 and 92.0 cm. The fluctuation of the water table depends on the irrigation interval and the distance from both irrigation canal in the north and main surface drain in the south of the experiment area. The absolute values of both minimum and a maximum depth of water table increased directly with increasing irrigation intervals and as much as close to the main open drain in the site. So, by increasing the irrigation intervals, more water is allowed to be depleted by growing plants and consequently further through fall may be obtained. This technique of elongate the irrigation interval in Nile Delta have the advantage of proper aeration in the effective root zone, minimizing the water logging hazard in the area and save a reasonable amount of irrigation water.

Table 4. Maximum, Minimum and mean values of water table depth cm. during the two growing seasons 2014/2015 and 2015/2016.

Observation Well	Treat.	2014/2015 Mini.	2014/2015 Max.	2014/2015 Mean	2015/2016 Mini.	2015/2016 Max.	2015/2016 Mean
1		57	80	69	60	80	70
2	I_1	60	84	72	64	86	75
3		70	88	79	68	90	79
1		75	89	82	70	96	83
2	I_2	78	90	84	74	99	87
3		80	95	88	80	100	90
	Mean	70	88	79	69	92	81

Contribution of water table:

Table (5) & Fig (2) showed the contribution of the water table to wheat evapotranspiration during the 2014/2015 and 2015/2016 seasons. Data illustrated that by increasing irrigation water, less water table contribution value was obtained. For the maximum irrigation water (treatment I_1) there was a little contribution from the water table. For the other treatments (I_2) average values of contribution are 2.07 and 8.12 cm. for I_1 and I_2 in the first season while it was 2.67 and 15.06 cm in the second seasons respectively.

The difference between the two seasons of the study is due to the amount of rain that came down in the first season where the rainfall was 172.7 millimeters while it was 86.61 mm in the second season These findings are an agreement with those obtained by (Eid, 2015)

On the other hand, the contribution was not affected by nitrogen fertilization rate. Data showed that mean value of contribution were 4.9, 5.04 and 5.35 cm for treatments N_0, N_{50} and N_{75} under irrigation regime I_1. The corresponding value were 7.99, 7.98 and 8.39 for I_2 treatment in the 2nd, Season respectively.

Table 5. Contribution of ground water table (S) as affected by the interaction between irrigation regime and fertilization rate.

	Season 2014/2015 I_1	I_2	N- Mean	Season 2015/2016 I_1	I_2	N- Mean
N_0	1.81	7.99	4.90	2.68	9.40	6.04
N_{50}	2.10	7.98	5.04	2.67	9.64	6.16
N_{75}	2.31	8.39	5.35	2.67	9.60	6.14
I- Mean	2.07	8.12	5.10	2.67	9.55	6.11

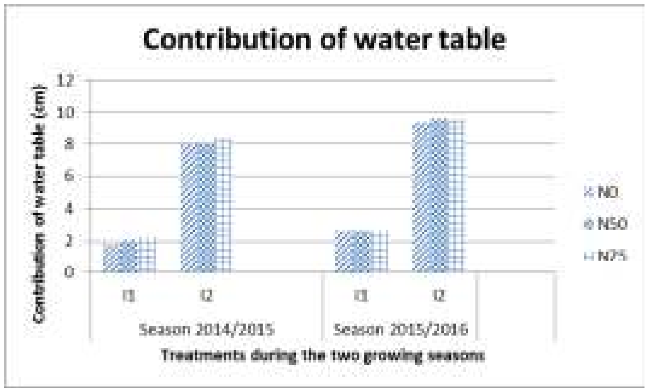

Fig. 2. Contribution of ground water table (S) as affected by the interaction between irrigation regime and fertilization rate.

Water applied (Wa):

Table (6) revealed that under the conditions of the present study,

Table 6. Seasonal irrigation (IW) cm, rainfall (R) cm, contribution from water table (S) cm, seasonal water applied (Wa) for wheat in the two seasons.

Treatments			First season					Second season				
Irrigation Depletion	Fertilization Doses	Fertilization Rate	No.of irrig.	Iw cm	RF cm	S cm	Wa cm	No.of irrig.	Iw cm	RF Cm	S cm	Wa cm
40%	D_1	N_0	5	43.10	17.26	1.76	62.12	5	45.48	8.64	2.69	56.81
		N_{50}	5	43.10	17.26	2.07	62.43	5	45.48	8.64	2.64	56.76
		N_{75}	5	43.10	17.26	2.55	62.91	5	45.48	8.64	2.64	56.76
	D_2	N_0	5	43.10	17.26	1.86	62.22	5	45.48	8.64	2.67	56.79
		N_{50}	5	43.10	17.26	2.12	62.48	5	45.48	8.64	2.69	56.81
		N_{75}	5	43.10	17.26	2.07	62.43	5	45.48	8.64	2.69	56.81
60%	D_1	N_0	4	34.76	17.26	8.36	60.38	4	38.10	8.64	9.4	56.14
		N_{50}	4	34.76	17.26	8.10	60.12	4	38.10	8.64	9.64	56.38
		N_{75}	4	34.76	17.26	8.45	60.47	4	38.10	8.64	9.6	56.34
	D_2	N_0	4	34.76	17.26	7.62	59.64	4	38.10	8.64	9.74	56.48
		N_{50}	4	34.76	17.26	7.86	59.88	4	38.10	8.64	10.24	56.98
		N_{75}	4	34.76	17.26	8.33	60.35	4	38.10	8.64	9.71	56.45

Grain and straw yield (Kg fed^{-1}):

Effect of N fertilization on wheat yield (grain and straw):

Table (7) and Fig (3) showed that the grain yield of wheat had significantly increased with increasing nitrogen fertilization during the tow growing seasons. The overall average of two seasons recorded relative increase by about 222% with N_{75} as compared to that treatment without N application N_0 (control). The obtained results are in a good agreement with those obtained by Amer (2005)

Table (8) and Fig (4) showed that the straw yield of wheat had significantly increased with increasing nitrogen fertilization during the tow growing seasons of the study. The overall average of two seasons recorded relative increase by about 187 % % with N_{75} as compared to that treatment without N_0 the obtained results are in a good agreement with those obtained by Amer (2005) and Amer. (2009).

Increasing nitrogen rates up to 75 kg N $fed.^{-1}$ (N_{75}) significantly increased grain yield by 234.4%, 119.0% and 218.5%, 111.2 % as compared to N_0; N_{50} treatments in the 1st and 2nd seasons respectively. Also increased straw yield by 192.9%, 111.4% and 182.4 %, 111.6% as compared to N_0; N_{50} treatments in the 1st and 2nd seasons respectively.

The highest straw yield occurred with I_1 interacted with N_{75} rate applied with D_2 mode (3972.50kgfed^{-1}), applied up to 75 kg Nfed^{-1} during the two growing seasons.

Table 7. Effect of nitrogen fertilizer rates (N_0, N_{50}andN_{75}) and dosses ($D_1$and D_2)under two irrigations regime($I_1$and I_2) on grain yield of wheat (kg fed^{-1}.) during the two growing seasons

		1st season			2nd season		
		D_1	D_2	N- Mean	D_1	D_2	N- Mean
I_1(40%)	N_0	1235.45 c	1235.45 c	1235.45	1211.45 c	1211.45 c	1211.45
	N_{50}	2364.50 b	2641.50 b	2503.00	2329.00 b	2630.95 b	2479.98
	N_{75}	2919.45 a	3107.55 a	3063.50	2549.55 a	2955.50 a	2752.53
I_2(60%)	N_0	1252.55 c	1252.55 c	1252.55	1225.55 c	1225.55 c	1225.55
	N_{50}	2265.05 b	2524.55 b	2394.80	2174.05 b	2443.00 b	2308.53
	N_{75}	2552.45 a	2983.00 a	2767.73	2459.95 a	2684.95 a	2572.45
	D- Mean	2081.58	2290.77	2186.17	1991.59	2158.57	2075.08

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT

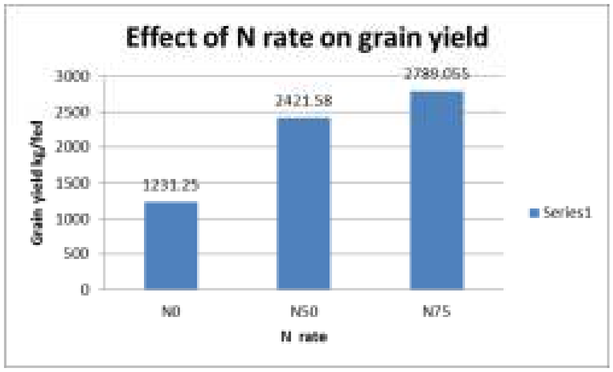

Fig. 3. Effect of N- fertilization on grain yield as overall average of two seasons

Table 8. Effect of nitrogen fertilizer rates (N_0, N_{50} and N_{75}) and doses ($D_1$and D_2) under two irrigations regime($I_1$and I_2) on straw yield (kg fed^{-1}) during the tow growing seasons.

		1[st] season			2[nd] season		
		D_1	D_2	N- Mean	D_1	D_2	N- Mean
	N_0	1927.50 c	1944.25 c	1935.88	1955.00 c	1967.60 c	1961.30
I_1(40%)	N_{50}	3355.00 b	3598.25 b	3476.63	3276.75 b	3525.98 b	3401.37
	N_{75}	3507.00 a	3972.50 a	3739.75	3570.75 a	3995.00 a	3782.88
	N_0	1944.25 c	1927.50 c	1935.88	1968.25 c	1968.25 c	1968.25
I_2(60%)	N_{50}	3083.25 b	3475.75 b	3279.50	2829.25 b	3210.75 b	3020.00
	N_{75}	3480.00 a	3896.75 a	3688.38	3245.00 a	3530.75 a	3387.88
	D- Mean	2882.83	3135.83	3009.33	2807.50	3033.06	2920.28

In a column under each I,, means followed by a common letter are not significantly different at the 5% level by DMRT.

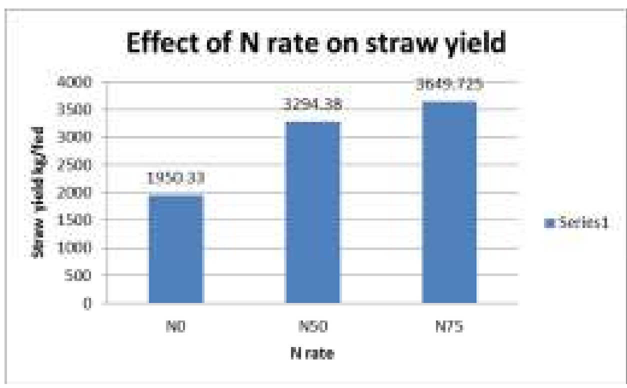

Fig. 4. Effect of N- fertilization on straw yield as overall average of two seasons

Effect of irrigation regime:

The highest grain and straw yields was obtained from (I_1) irrigation at 40% depletion (2567.317& 4372.50Kg fed^{-1}) while irrigation at 60% depletion (I_2), produced the lowest grain and straw yields (2326.027&4048.33Kg fed^{-1}) in the 1[st] season while it was (2581.32, 4358.75Kg fed^{-1}) for I_1 and (2318.82, 4063.08Kg fed^{-1}) for I_2 in the2[nd] season respectively.

Results in Tables (9&10) showed that higher values of grain and straw yields resulted from (I_1) However; the lowest values resulted from I_2. Irrigation depletion treatment of (I_1) significantly increased grain yield by 9.18%, and straw yield by 6.8% in the first season while it was 10.2 and 6.2% in the second seasons.

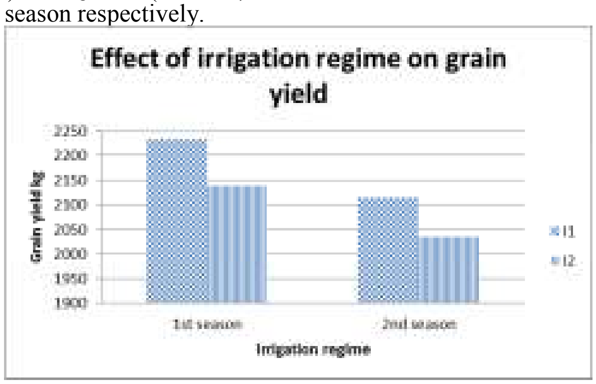

Fig. 5. Effect of irrigation regime (I_1&I_2) on grain yield.

Effect of N application methods:

Results in Table (9&10) and Fig (6) showed that higher values of grain and straw yields resulted from (D_2) However; the lowest values were resulted from D_1. Nitrogen application at two times D_2 significantly increased grain yield by 10.04 %, and straw yield by 8.70% in the 1st season while it was 8.3 and8.2% in the 2nd seasons.

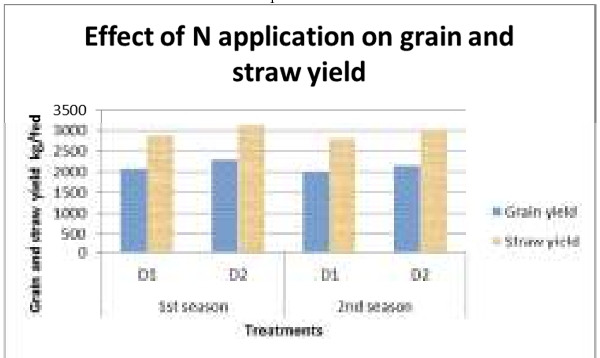

Fig. 6. Effect of N application (D_1&D_2) on grain and straw yields.

Water productivity (WP):

Tables (9&10). Reveled that water productivity expressed in kg of grain yield m^{-3} of water consumed. The obtained results showed that WP increased as the irrigation water applied decreased. wheat irrigated at 60% depletion (I_2) and applied nitrogen fertilizer N_{75} as tow times (D_2) had the highest value of WP to be 2.71,4.2 and 3.18,5.10 Kg of grain and straw yield m^{-3} of water consumed, while the lowest one was 1.65,3.41 and 1.79, 3.56 Kg of grain and straw yields m^{-3} of water consumed, resulted from watering at 40% depletion and applied nitrogen fertilizer (N_{50}) and applied fertilizer in one time (D_1) in the 1st season and 2nd respectively. These results could be regarded to the highly significant differences among grain wheat yield as well as differences between water consumed.

Productivity of irrigation water (PIW):

Mean values of PIW as affected by irrigation regime and rate of nitrogen fertilizer are shown in Tables (9&10). Results indicated that the highest values of PIW were recorded from the irrigation at 60% depletion (I_2) whereas the lowest ones were obtained from irrigation at 40% depletion (I_1). These results may be caused to soil moisture depletion (Cu) and water applied values. Results in tables (9&10) cleared that with increasing the no of irrigation, both PIW of grain and straw yields increased. The highest average values of PIW 2.71 and 4.20 kg/m^3 for grain and straw yield, respectively, were obtained under treatment watering at 60% depletion (I_2), while the lowest ones 0.90 and 1.85 kg/m^3, respectively were obtained under treatment watering at 40% depletion (I_1). These results indicate that increasing irrigation at from (I_2) up to (I_1) increased the PIW of grain and straw yield by about 300% and 227% respectively.

Table 9. soil moisture depletion water applied Wa, grain yield kg fed^{-1},water productivity (WP) and irrigation water productivity (PIW) during 1st season and 2nd seasons.

Irrigation Depletion	Fertilization Doses	Fertilization Rate	Wa	Grain yield	WP	PIW	Wa	Grain yield	WP	PIW
40%	D1	N_0	2735	1235.45	0.82	0.45	2638	1211.45	0.86	0.46
		N_{50}	2748	2364.50	1.58	0.86	2636	2229.00	1.65	0.88
		N_{75}	2768	2819.45	1.98	1.05	2636	2549.55	1.80	0.97
	D2	N_0	2739	1235.45	0.82	0.45	2637	1211.45	0.86	0.46
		N_{50}	2750	2641.50	1.77	0.96	2638	2630.95	1.86	1.00
		N_{75}	2790	3107.55	2.08	1.11	2638	2955.50	2.09	1.12
60%	D1	N_0	2494	1252.55	0.90	0.50	2568	1225.55	1.05	0.48
		N_{50}	2525	2265.05	1.66	0.90	2578	2174.05	1.87	0.84
		N_{75}	2540	2552.45	1.89	1.00	2618	2459.95	2.19	0.94
	D2	N_0	2505	1252.55	0.90	0.50	2582	1225.55	1.06	0.47
		N_{50}	2515	2524.55	1.84	1.00	2603	2443.00	2.15	0.94
		N_{75}	2535	2983.00	2.20	1.18	2623	2884.95	2.40	1.02

Table 10. soil moisture depletion water applied Wa, straw yield kg fed^{-1},water productivity (WP) and irrigation water productivity (PIW) during 1st season and 2nd season.

Irrigation Depletion	Fertilization Doses	Fertilization Rate	Wa	straw yield	WP	PIW	Wa	straw yield	WP	PIW
40%	D1	N_0	2735	1944.25	1.29	0.71	2638	1968.25	1.39	0.75
		N_{50}	2748	3083.25	2.07	1.12	2636	2829.25	2.00	1.07
		N_{75}	2768	3480.00	2.36	1.26	2636	3245.00	2.30	1.23
	D2	N_0	2739	1927.50	1.28	0.70	2637	1968.25	1.39	0.75
		N_{50}	2750	3475.75	2.33	1.26	2638	3210.75	2.27	1.22
		N_{75}	2790	3996.75	2.68	1.43	2638	3530.75	2.50	1.34
60%	D1	N_0	2494	1927.50	1.38	0.77	2568	1955.00	1.67	0.76
		N_{50}	2525	3255.00	2.38	1.29	2578	3276.75	2.82	1.27
		N_{75}	2540	3507.00	2.60	1.38	2618	3570.75	3.18	1.36
	D2	N_0	2505	1944.25	1.40	0.78	2582	1967.60	1.70	0.76
		N_{50}	2515	3598.25	2.62	1.43	2603	3525.98	3.10	1.35
		N_{75}	2535	3872.50	2.86	1.53	2623	3995.00	3.58	1.52

Nitrogen use efficiency (NUE):

Fig (7) showed NUE of wheat decreased by increasing N level up to 75 kg fed^{-1}, Values of NUE due to N_{50} and N_{75} were 24.08 and 16.68 in the 1^{st} season, while it was 23.05 and 13.70 kg/unite N in the 2^{nd} season respectively. The highest value reached 28.1 kg grain yield were observed with irrigation at 40% depletion (I_1), nitrogen rate 50 kg (N_{50}) and two times application (D_2), and the least ones 11.5 kg grain yield were obtained with irrigation at 60% depletion, nitrogen rate 75kg and one time application (D_1). This mean that NUE values increased with increasing the irrigation water applied.

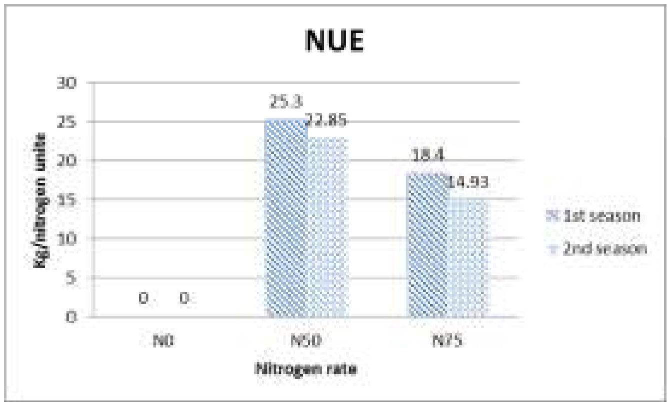

Fig.7. Nitrogen use efficiency as affected by applied nitrogen.

CONCLUSION

The results of this work indicated that the highest grain and straw yield for wheat planted in both growing seasons of 2014/2015 and 2015/2016 was obtained when the plants were irrigated 40% depletion, nitrogen rate 75 kg and applied nitrogen on tow times. However, the highest water productivity and save about 320 m^3 was obtained under irrigation at 60% depletion in both growing, Therefore, it is recommended to apply irrigation water at 60% depletion to save irrigation water and to increase water productivity under 75 kg N fed^{-1}

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محصول القمح وبعض العلاقات المائيه تحت تأثير معدلات الري ومعدلات وجرعات مختلفه من التسميد النيتروجيني في شمال الدلتا.

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اقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا بمحافظة كفرالشيخ بمصر خلال موسمى الدراسة 2015/2014 و 2016/2015 بهدف (1) دراسة تاثير الرى عند استنفاذ 40% و 60% من الرطوبة الارضية (2) تاثير مستويات مختلفة من السماد النتروجينى (صفر و50 و75 وحدة ازوت للفدان) وطرق اضافته على مرة واحدة او مرتين على النمو والانتاج وكفاءة وحدة المياة والسماد النيتروجيني عن طريق استخدم تصميم الشرائح المنشقه مرتين فى ثلاث مكررات حيث خصصت القطع الرئيسية للرى عند استنفاذ 40% (I_1) من الرطوبة والرى عند استنفاذ 60% من الرطوبة (I_2) اما القطع التحت رئيسية فكانت معدلات التسميد صفر و 50 و 75 كيلو نتروجين/الفدان (N_0 و N_{50} وN_{75}) على التوالى اما القطع التحت تحت رئيسية فكانت اضافة السماد على دفعة واحدة (D_1) وعلى دفعتين (D_2). وأظهرت النتائج أن الري عند استنفاذ 40% من الرطوبة الارضيه زادت زيادة معنوية فى محصول الحبوب بنسبة 9.4، 10.3٪ والتبن بنسبة 6.8، 6.3٪ مقارنة بالري عند استنفاذ 60٪ من الرطوبه الارضيه خلال مواسم الدراسة على التوالي. كما اشارت النتائج ان محصول الحبوب كان 3107.43 و2955.5كجم للفدان تحصل علية من المعاملة $I_1N_{75}D_2$ بينما اقل محصول حبوب كان 2265.05 و 2174.05كجم للفدان من المعاملة $I_2N_{50}D_1$ وذلك خلال الموسم الاول والثانى على التوالي . كما أدى الري عند استنفاد 40% من الرطوبة الارضيه إلى زيادة كمية مياه الري إلى 1810 و 1920 م 3 للفدان موزعة على 5 ريات بينما كان 1460 و 1600 م 3 / للفدان مروية عند استنفاذ 60٪ من الرطوبه الارضيه موزعة على 4 ريات خلال الموسمين الأول والثاني على التوالي . تم الحصول على أعلى استهلاك مائى عندما رويت الارض عند استنفاذ 40٪ من الرطوبة الارضيه. 35، 33 سم. في حين كان أقل إستهلاك مائى كان 32، 27 سم تم الحصول عليه من الري عند استنفاد 60٪ من الرطوبة الارضيه . كما لوحظ انه بزيادة معدل تسميد النتروجين الى 75 كيلو للفدان (N_{75}) زاد محصول الحبوب زيادة معنوية قدرها 234.4% و 119.0% بالمقارنه بالمعاملات N_0(كنترول) و N_{50} فى موسم الدراسة الاول اما موسم الدراسة الثانى كانت الزياده 218.5,% و 111.2% بالمقارنة لنفس المعاملات , أيضا محصول التبن زاد زيادة معنوية قدرها 192.9% و111.4% للمعاملة (N_{75}) مقارنه بالمعاملات (كنترول)N_0 و N_{50} فى الموسم الاول اما الموسم الثانى فكانت الزياده 182.4% و111.6% بالمقارنة لنفس المعاملات على التوالي . أما كفاءة الاستفاده من استخدام النتروجين(NUE) فكانت صفر و 42.07 و24.23 للمعاملات N_0 وN_{50} وN_{75} فى الموسم الاول اما الموسم الثانى فكانت صفر و 31.74و 17.32 لنفس المعاملات على التوالي . والنتائج اوضحت انه بزيادة معدل التسميد يقلل من كفاءة استخدامه ولذلك كانت اعلى كفاءة لاستخدام النتروجين (NUE)عند المعاملة N_{50} واقل كفاءة كانت للمعامله N_{75} .ولذلك يمكن التوصيه بالتسميد حسب المعامله N_{50} للحصول علي اعلي كفائه استخدام للنيتروجين المضاف . وبالنسبه للكفاءة الانتاجية للمياه (WP) فكانت اعلي عند استنفاذ 60% من الرطوبه الارضيه أي الري اربع ريات فقط وذلك في شمال دلتا النيل حيث وفرت 320 متر مكعب للفدان والتي نوصي باللجوء اليها في حاله الحاجه لتوفير المياه والحفاظ علي انتاجيه المحصول عند نقص المياه.اما بالنسبه للحصول علي اعلي محصول حبوب وتبن فنوصي باستخدام المعامله ($I_1N_{75}D_2$) والتي حققت اعلي انتاجيه لمحصول الحبوب والتبن .