Response of Grain Yield and Some of its Components, Water Produvtivity and Nitrogen Use Efficiency For Some Bread Wheat Cultivars to N - Rate Under Deficit Irrigation, Induced Via Corrugation Method, on Vertisol

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ABSTRACT

Two field trials were conducted in 2007/08 and 2008/09 winter seasons, at Gemmeiza Agricultural Research Station Farm, Middle Nile Delta, Egypt, aiming at determining the extent to which the performance of some bread wheat cultivars; namely, Giza 168, Sakha 94 and Gemmeiza 9 responded to N-rates; viz, 50,70 and 90 Kg /fed, under corrugation irrigation, compared with the common farmer irrigation practice prevailing in the area. The adopted treatments were assessed in a split- spilt plot design, with three replicates. Grain yield and its components, water productivity and N-use efficiency, for the adopted wheat cultivars, were in consideration. The most important findings could be summarized as follows:-

1. Irrespective of wheat cultivars and N- rates effects, wheat grain yield was significantly increased under corrugation practice by 8.96 and 10.47%, in the first and the second seasons, respectively, as compared with the farmer's irrigation practice. The grain yield components; i.e., number of spikes/m^2, number of kernels/spike and 1000-kernel weight traits seemed to increase, with different levels of significance, under corrugation practice in the two seasons of study. The saved irrigation water ranged between 17.21 and 16.29%, respectively, in the first and second seasons, respectively. Corrugation practice exhibited higher values for water productivity and N-use efficiency in the first and second seasons, comparable with the farmer's irrigation practice. The improved values, for all investigated parameters, under corrugation practice, could be ascribed to its potency to optimize soil water in the root zone throughout the even water distribution over the field during the entire growing season.
2. Regardless of the influence of both irrigation practices and N-rates, grain yield of Sakha 94 cultivar surpassed those for Giza 168 and Gemmeiza 9 cultivars with different significant levels, in the first and second seasons, respectively. Sakha 94 cultivar exhibited higher number of spikes/m^2 than these of Giza 168 and Gemmeiza 9 cultivars and the differences were significant in the two seasons of study. Gemmeiza 9 cultivar exhibited higher values of number of kernels/ spike and 1000- kernel weight than those of Sakha 94 and Giza 168 cultivars. However, the significant levels differed in the two successive seasons.
3. Regarding the impact of the tested N rates, irrespective of both irrigation practices and wheat cultivars under investigation, increasing N rate, in general, tended to significantly increase wheat grain yield and its components and such findings were true in the two seasons of study. Moreover, increasing N- rate resulted in higher values for water productivity. Nevertheless, increasing N rate, in general, retarded N- use efficiency.
4. All interaction types did not significantly affect the grain yield and its components. However, higher values of grain yield and number of spikes/m^2 were recorded for Sakha 94 cultivar, as interacted with 90 Kg N/fed rate under corrugation irrigation. In addition, both Sakha 94 and Gemmeiza 9 cultivars exhibited higher values for number of kernels/spike and 1000-kernel weight, as interacted with 90 Kg N/fed rate under corrugation irrigation practice.

Key Words: Wheat cultivars, deficit irrigation, corrugation irrigation, N- rates, grain yield and its components, water productivity, N-use efficiency.

INTRODUCTION

In Egypt, bread wheat (*Triticum aestivum,* L.) is the most important cereal crop. However, the gab between the local production and consumption is continuously increased due to increasing the population with limited planted area. Hence, increasing wheat production, either horizontal or vertical, through scientific basis is a national target. Raising the newly reclaimed areas with drought tolerant cultivars, under modern irrigation systems, will increase wheat production horizontally. Meanwhile, growing of high yielding cultivars and applying the proper cultural practices may increase wheat production vertically.

Nitrogen application has a positive effect in increasing wheat grain yield when native soil nitrogen availability is low in relation to the grain yield potential of the grown cultivars. In addition, nitrogen is a building block of amino acids and, consequently, protein in plants. As much as 70% of the total leaf nitrogen may be found in chloroplasts (Stocking and Ongun, 1962). So, it is necessary for photosynthesis, plant growth and grain yield. In this respect, El-Refaie and EL-Kabbany (1995) reported that application of N up to 90 kg /fed significantly increased grain and straw yields, cholorophyll content and N,P and K contents in both wheat grain and straw yields. Moreover, Mosalem *et al.* (1999) and Halvorson et al. (2004) found that increasing nitrogen application increased grain yield and its components, such as number of spickes/m2 and number of grain weight/spike.

In Egypt, the water and agricultural land resources are limited, so, it is a must to use such resources, efficiently, in order to accomplish the sustainable agriculture concept. In the context of improving water productivity, there is a growing interest in deficit irrigation, which is an irrigation practice whereby water supply is reduced below maximum levels and mild stress is allowed with minimal effects on yield. Such practice can be induced via some irrigation practices; e.g., bed-furrow, surge, alternate- furrow, omitting irrigation at certain crop growth stages, corrugation, ...etc, Such irrigation methods proved to be effective to reduce the losses in water during irrigating a grown crop. In connection, Stegman *et al.* (1980) stated that deficit irrigation ensured optimum and sustainable agricultural production, in a given region, and maximized incomes of the growers, if irrigation water resources were limited or expensive. Walker and Skogerboe (1987) reported that use of furrows or bed – and furrows irrigation methods had considerable advantages over basin irrigation systems, because they provided better on-farm water management, evaporative losses could be reduced and higher efficiencies were in general, achieved. Moreover, Ahmad *et al.* (2010) evaluated different irrigation techniques (border/flat, bed- and furrow methods) to irrigate wheat crop, and found that bed-furrow method consumed about 35.6% less water, as compared to flat border irrigation method.

The present research trial aimed to findout how the performance of some wheat cultivars responded to different N- rates under corrugation irrigation method. Applied water, beside grain yield and its components, water productivity and nitrogen use efficiency for the adopted wheat cultivars, were in consideration.

MATERIALS AND METHODS

Two field trials were conducted in 2007/08 and 2008/09 winter seasons, at Gemmeiza Agricultural Research Station Farm, Middle Nile Delta, Egypt. The experiments aimed at determining the extent to which the performance of some bread wheat cultivars responded to N-rate under deficit induced irrigation, using the corrugation irrigation, compared with the common practices prevailing in the area. Corrugation irrigation is a method of surface irrigation, similar to furrow irrigation, where small channels, called corrugates, are used to guide water across the field in a uniform manner (Stewart and Nielsen,1990). Such irrigation method is mostly used for irrigation of close growing crops, such as wheat, barley and alfalfa. Grain yield and its components,water productivity and N-use efficiency were estimated for the adopted wheat cultivars in Egypt. The soil of the experimental site was clayey in texture and its particle size distribution, field capacity and wilting points are shown in Table (1). The split- plot area was 72 m^2(3.6 m wide x 20 m long), including eighteen wheat plant rows and eight corrugates; i.e., one corrugate for each pair of wheat plant row.

The adopted treatments were assessed in a split-split plot experimental design, with three replicates, as follows:

1. Main plots (irrigation practice).

1a- Traditional farmer practice.

1b- Corrugation irrigation. The corrugates were, manually, established as one corrugate for each two rows of wheat plants. Each corrugate was 8 cm wide and 6cm deep, which was constructed before Mohyah watering.

Table 1: Particle size distribution, field capacity and wilting points of the experimental site.

Soil depth (cm)	Clay (%)	Silt (%)	Fine sand (%)	Coarse sand (%)	Texture class	F.C.* (%),wt/wt	W.P.** (%),wt/wt
0 0-15	40.19	44.84	14.14	0.83	Clayey	43.20	23.4
15.-30	46-10	40.11	12.68	1.11	Clayey	41.10	22.34
30-45	48.90	39.73	10.12	1.22	Clayey	39.6	2152
45-60	49.00	39.95	10.00	1.05	Clayey	36.00	19.57

* Field water capacity.

** Permanent wilting point.

2, Split (sub-) plots (wheat cultivars), where three wheat cultivars; namely, Giza 168, Sakha 94 and Gemmeiza 9, were under study.

3, Split- split (sub-sub-) plots (N- rates).

3a- 50 Kg N/feddan, 3b -70 Kg N/feddan and 3c-90 Kg N / feddan.

Irrigation water was conveyed to the plots through a circular orifice and its quantity was calculated, using the equation of immersed orifice, as follows:

$Q = 0.61 \times 0.443 \times A\sqrt{h}$ (after James, 1988), where,

Q= Orifice discharge, L/s.

A= Area of orifice (cm^2).

h=Effective water head over the orifice center(m).

The adopted nitrogenous fertilizer rate was applied in two equal doses, just before the Mohyah irrigation and the next one in urea form (46.5% N). All of the cultural practices; e.g., sowing date, seeding rate, pest control,...etc., were done as recommended for wheat production in the area. The following parameters were under investigation:

1, Grain yield: Determined as kg per one square meter, from each sub- sub- plot and, then, expressed as ardab/feddan.

2, Grain yield components; i.e., number of spikes/ m^2, number of kernels/spike and 1000 - kernel weight.

3, Applied irrigation water.

4, Water productivity. 5- Nitrogen use efficiency.

Data of grain yield and its components were subjected to the statistical analyses, as described by Snedecor and Cochran (1980), and the means were compared by the L.S.D. test at 5% level.

RESULTS AND DISCUSSION

Grain yield and its components:

1- Number of spikes /m^2:

Data presented in Table (2) revealed that the adopted irrigation practices significantly affected the number of spikes/m^2 in the first and second seasons.The highest figures for number of spikes/m^2 were obtained under corrugation irrigation practice, as compared with the farmer traditional one.

Data, also showed, that the number of spikes/m^2 was significantly influenced by wheat cultivars under investigation in the two seasons of study. In this respect, Sakha 94 cultivar surpassed both Giza 168 and Gemmeiza 9 cultivars with percentages reaching 5.85 and 5.59 and 6.18 and 5.58, in the first and second seasons, respectively. In this sense, Jack and Major (1994) stated that the number of spikes per plant was the most important grain yield component determining final wheat grain yield.

Data further indicated that increasing N rate led to a significant remarkable increase in the number of spikes/m^2 in both seasons. The increases in such character comprised 15.16 and 27.87%, in the first season, 15.17 and 27.52%, in the second one, under 70 and 90 Kg N/fed rates, respectively, comparable with 50 kg N/fed rate. These results agreed with those of Mosalem *et al.* (1990). In connection, Halvorson *et al.* (2004) reported that N level of 124-126 kg/ha was sufficient to optimize winter wheat grain yield in USA. Data clarified that all types of interactions were insignificant to alter the number of spikes/m^2. However, the highest value was recorded for Sakha 94 cultivar grown under corrugation practice and received 90 kg N/fed in the two seasons of study.

2- Number of kernels / spike:

Data in Table (3) revealed that, regarding irrigation practices under study, the number of kernels /spike, in the first season, was significantly increased by 1.28% under corrugation irrigation practice, as compared with the farmer irrigation one. Moreover, in the second season, the same trend was noticed, however, the difference did not reach the significance level.

Data in Table (3), also, indicated that the number of kernels /spike was significantly influenced by the tested wheat cultivars, only, in the first season. Gemmeiza 9 cultivar seemed to exceed Giza 168 and Sakha 94 cultivars in both seasons. Such differences might be due to varietal variability among the cultivars under study. Ali (1997), Abd EL-Majeed *et al.* (1998) and Abd EL-All and Azza (1999) detected differences in the number of kernels/spike criterion among wheat cultivars.

Increasing N rate resulted in remarkable significant increases in the number of kernels / spike (Table 3). The increased percentages comprised 3.99 and 9.66%, in the first season, and 7.84 and 12.51%, in the second season, under 70 and 90 kg N/fed rates, respectively, as compared with 50 kg N/fed one. The obtained results could be attributed to the important role of N in spike fertility and grain development, as previously justified by Bruckner and Morey (1988) and Iskandar (2000). All types of interactions were almost insignificant to alter the number of kernels/spike, however, Gemmeiza 9 and Sakh 94 cultivars produced higher values as both interacted with 90 kg N/fed level under corrugation practice, in the first and second seasons, respectively.

Table 2: Means of number of spikes/m^2 for the adopted wheat cultivar under N-rates and irrigation practices in 2007/08 and 2008/09 seasons.

Irrigation practices (a)	Wheat cultivars (b)	Nitrogen Rates (c)	Number of spikes/m^2 2007/08	2008/09	Mean
Farmer irrigation	Giza 168	50	297.50	291.66	294.58
		70	336.53	330.00	333.27
		90	397.80	383.33	390.57
	Mean		343.94	335.00	339.47
	Sakha 94	50	314.50	308.33	311.42
		70	365.50	358.33	361.92
		90	409.70	401.66	405.68
	Mean		363.23	356.11	359.67
	Gemmeiza 9	50	311.10	305.00	308.05
		70	348.50	341.66	345.08
		90	367.20	360.00	363.60
	Mean		342.26	335.55	338.91
Corrugation irrigation	Giza 168	50	317.90	311.66	314.78
		70	350.20	343.33	346.77
		90	397.80	390.00	393.90
	Mean		355.30	348.33	351.82
	Sakha 94	50	314.50	308.33	311.42
		70	394.40	386.66	390.53
		90	421.76	413.33	417.55
	Mean		376.88	369.44	373.16
	Gemmeiza 9	50	316.20	310.00	313.10
		70	360.40	353.00	356.70
		90	399.50	391.66	395.58
	Mean		358.70	351.66	355.18
Average for all irrigation regimes	Giza 168	50	307.70	301.66	304.68
		70	343.36	336.66	340.01
		90	397.62	386.66	392.14
	Mean		349.62	341.66	345.64
	Sakha 94	50	314.50	308.33	311.42
		70	379.95	372.50	376.23
		90	415.73	407.50	411.62
	Mean		370.06	362.77	366.42
	Gemmeiza 9	50	313.65	307.50	310.58
		70	354.45	347.50	350.98
		90	383.35	375.83	379.59
	Mean		350.48	343.61	347.05
L.S.D. 0.05	Irrigations (a)		14.266	13.821	
	Cultivars (b)		20.005	20.140	
	N- rates (c)		15.096	14.850	
	(a x b)		n.s	n.s	
	(a x c)		n.s	n.s	
	(b x c)		n.s	n.s	
	(a x b x c)		n.s	n.s	

n.s. = Not significant.

Table 3: Means of number of kernels / spike for the adopted wheat cultivars under N-rates and irrigation practices in 2007/08 and 2008/09 seasons.

Irrigation practices (a)	Wheat cultivars (b)	Nitrogen Rates (c)	Number of kernels /spike		Mean
			2007/08	2008/09	
Farmer irrigation	Giza 168	50	58.40	68.13	63.27
		70	65.26	70.66	67.96
		90	55.33	73.46	64.40
	Mean		59.66	70.75	65.21
	Sakha 94	50	65.40	65.06	65.23
		70	65.26	70.50	67.88
		90	59.46	74.13	66.80
	Mean		63.37	69.90	66.64
	Gemmeiza 9	50	60.20	67.53	63.87
		70	58.40	69.80	64.10
		90	64.06	73.13	68.60
	Mean		60.88	70.15	65.52
Corrugation irrigation	Giza 168	50	65.80	66.86	66.33
		70	64.66	72.53	68.60
		90	62.86	73.60	68.23
	Mean		64.44	71.00	67.72
	Sakha 94	50	61.66	64.33	63.00
		70	57.46	69.20	63.33
		90	58.73	76.20	67.47
	Mean		59.28	69.91	64.60
	Gemmeiza 9	50	61.00	63.86	62.43
		70	60.46	74.06	67.26
		90	66.13	74.73	70.43
	Mean		62.53	70.83	66.71
Average for all irrigation regimes	Giza 168	50	62.10	67.50	64.80
		70	64.96	71.60	68.28
		90	59.10	73.53	66.32
	Mean		62.05	70.87	66.46
	Sakha 94	50	63.53	64.70	64.12
		70	61.36	69.85	65.61
		90	59.10	75.16	67.13
	Mean		61.33	69.90	65.62
	Gemmeiza 9	50	60.60	65.70	63.15
		70	59.43	71.93	65.68
		90	65.10	73.93	69.52
	Mean		61.71	70.52	66.12
L.S.D. 0. 05	Irrigation(a)		0.773	n.s	
	Cultivar(b)		0.362	n.s	
	N- rate(c)		1.230	2.797	
	(a x b)		n.s	n.s	
	(a x c)		n.s	n.s	
	(b x c)		2.972	n.s	
	(a x b x c)		n.s	n.s	

n.s. = Not significant

3- 1000-kernel weight:

Data in Table (4) clarified that 1000-kernel weight seemed to be significantly increased, in the second season, under corrugation irrigation practice by 5.59% more than that under farmer irrigation. However, in the first season, a similar trend was obtained without a significant difference.

Data, also, revealed that 1000-kernel weight did not significantly differ due to the adopted wheat cultivars under investigation and such findings were observed in the two seasons of study. However, Gemmeiza 9 cultivar surpassed Giza 168 and Sakha 94cultivars in this respect, where the increases in percentages were 8.33 and 5.88 and 12.38 and 8.34, in the first and second seasons, respectively.

Concerning 1000-kernel weight trait, as affected by the adopted N- rates, data in Table (4) indicate that increasing N- rate tended to increase such trait in the two seasons of study. The differences were insignificant in the first season, while, in the second season, the differences reached the significant level, which comprised 4.75 and 9.70%, increase, under 70 and 90 kg N/fed rates, respectively, compared with 50 kg N / fed one. Data, also, indicated that all types of interactions were insignificant to alter 1000-kernel weight. However, higher values for such trait was obtained from Gemmeiza 9 and Sakha 94 cultivars as both interacted with 90 kg N/fed rate under corrugation practice in the first and second seasons, respectively,

4- Grain yield:

Data in Table (5) pointed out that wheat grain yield, irrespective of the adopted wheat cultivars and N-rates under investigation, was significantly increased under corrugation practice by 8.96 and 10.47%, in first and second seasons, respectively, as compared with the farmer irrigation practice.

Data, also, detected that, regardless of irrigation practices and N-levels, Sakha 94 cultivar significantly surpassed both Giza168 and Gemmeiza 9 cultivars in the first season, where the increased values comprised 33.08 and 25.76%, respectively. In the second season, the same trend was observed, since the corresponding increases reached 15.84 and 6.47%, however, the differences were insignificant.

As for grain yield, as affected by the adopted N-rates, data revealed that increasing N-level resulted in significant grain yield increases, irrespective of the adopted irrigation practices and wheat cultivars. The increase in percentages amounted to 7.01 and 13.96, in the first season, and 5.22 and 15.66 in the second one, due to 70 and 90 kg N/fed rates, respectively, compared with 50 kg N/fed one. These findings are in accordance with those of El-Refaie and EL-Kabbany (1995) who reported that application of N up to 90 kg /fed significantly increased grain and straw wheat yields. In addition, all types of interactions were insignificant for influence on the grain yield trait, however, the highest value was recorded for Sakha 94 cultivar, grown under corrugation practice and 90 kg N/fed treatment in the two seasons.

It is worthy to notice, from the abovementioned results that, although the applied irrigation water under deficit practice via corrugation irrigation were less than those applied, using the traditional farmer practice, all of the studied grain yield and its components parameters were improved under the farmer irrigation practice. This could be due to the potency of such irrigation practice to distribute the applied water evenly over the field. So, each plant had the same opportunity to absorb the soil water and nutrients, during the growing season, which, in turn, improved both the wheat grain yield and its components.

5- Applied irrigation water:

Data in Table (6) illustrated that applied irrigation water under corrugation irrigation practice, regardless of wheat cultivars and N- rates, were reduced by 17.21 and 16.29% in the first and second seasons, respectively, compared with the farmer practice. In this sense,Walker and Skogerboe (1987) reported that use of furrows or bed - furrows irrigation methods had considerable advantages over basin irrigation systems, because they provided better on-farm water management, evaporative losses could be reduced and higher efficiencies were, generally, achieved, as compared to the basin irrigation method. In connection, Fahong *et al.* (2004) found that, changing flat planting and flood irrigation to raised–bed planting and furrow irrigation, saved17% of applied water to wheat crop. Moreover, Ahmad *et al.* (2010) evaluated different irrigation techniques (border/flat, bed- and furrow methods) and found that bed furrow method consumed about 35.6% less water, as compared to flat border irrigation method.

6- Water productivity (WP):

Water productivity is an efficiency term, calculated as a ratio of product output (goods and services) over water input. The output could be biologically better such as crop grain, fodder....etc. So, water productivity, in the present study, was expressed as kilograms of wheat grain yield obtained due to applying one mm depth of irrigation water per feddan. Data in Table (6) reveal that WP, under corrugation irrigation practice, regardless of wheat cultivars and N- rates under investigation, surpassed that under the farmer practice by 26.05 and 31.86% in the first and second seasons, respectively. In this sense, Fahong *et al* (2004) found that, changing flat planting and flood irrigation to raised–bed planting and furrow irrigation, improved WUE for wheat by 21-30%. In addition, Jensen *et al*(2002) and Lovelli *et al.*(2007) reported that, generally, it was accepted for forages and other crops that water deficiency determined a more efficient water use. The present results might

Table 4: Means of 1000 - kernel weight for the adopted wheat cultivars under N-rates and irrigation practices in 2007/08 and 2008/09 seasons.

Irrigation Practices (a)	Wheat cultivars (b)	Nitrogen rates (c)	1000-kernel weight 2007/08	1000-kernel weight 2008/09	Mean
Farmer irrigation	Giza 168	50	45.33	40.39	42.86
		70	44.92	41.73	43.33
		90	46.25	45.03	45.64
	Mean		45.50	42.38	43.94
	Sakha 94	50	44.64	41.17	42.91
		70	45.68	43.43	44.56
		90	45.00	45.34	45.17
	Mean		45.10	43.31	44.21
	Gemmeiza 9	50	45.49	42.80	44.15
		70	46.98	46.13	46.56
		90	48.58	47.34	47.96
	Mean		47.02	45.42	46.22
Corrugation irrigation	Giza 168	50	44.58	42.84	43.71
		70	42.79	43.84	43.32
		90	46.29	46.36	46.33
	Mean		44.56	44.34	44.45
	Sakha 94	50	46.81	44.30	45.56
		70	47.53	44.79	46.16
		90	46.74	50.83	48.79
	Mean		47.03	46.64	46.84
	Gemmeiza 9	50	48.89	43.96	46.43
		70	44.77	47.66	46.22
		90	48.98	50.12	49.55
	Mean		47.55	47024	47.40
Average for all irrigation regimes	Giza 168	50	44.96	41.61	43.29
		70	43.85	42.78	43.32
		90	46.27	45.69	45.98
	Mean		45.03	43.36	44.20
	Sakha 94	50	45.73	42.73	44.23
		70	46.60	44.11	45.36
		90	45.87	48.09	46.98
	Mean		46.07	44.98	45.53
	Gemmeiza 9	50	47.19	43.38	45.29
		70	45.88	46.89	46.39
		90	48.78	48.73	48.76
	Mean		47.28	46.33	46.81
L.S.D. 0.05	Irrigations(a)		n s	2.370	
	Cultivars (b)		n s	ns	
	N- rates (c)		n s	2.386	
	(a x b)		n s	ns	
	(a x c)		n s	ns	
	(b x c)		n s	ns	
	(a x b x c)		n s	ns	

n.s. = Not significant

Table 5: Means of grain yield for the adopted wheat cultivars under both N-rates and irrigation practices in 2007/08 and 2008/09 seasons,

Irrigation practices (a)	Wheat cultivars (b)	Nitrogen rates (c)	Grain yield, ardab/fed 2007/08	Grain yield, ardab/fed 2008/09	Mean
Farmer irrigation	Giza 168	50	12.549	13.521	13.035
		70	12.990	13.780	13.385
		90	14.641	14.169	14.405
	Mean		13.393	13.824	13.608
	Sakha 94	50	16.978	13.716	15.347
		70	18.705	14.839	16.772
		90	19.375	16.567	17.971
	Mean		18.353	15.041	16.697
	Gemmeiza 9	50	14.602	13.176	13.889
		70	15.117	14.343	14.730
		90	15.682	17.366	16.524
	Mean		15.133	14.961	15.047
Corrugation irrigation	Giza 168	50	14.904	13.047	13.975
		70	15.228	14.386	14.807
		90	16.394	16.330	16.362
	Mean		15.509	14.588	15.049
	Sakha 94	50	18.226	17.431	17.828
		70	20.364	17.992	19.178
		90	21.747	18.187	19.967
	Mean		20.113	17.781	18.992
	Gemmeiza 9	50	14.312	15.358	14.835
		70	15.561	15.358	15.459
		90	16.494	17.129	16.812
	Mean		15.456	15.949	15.702
Average for all irrigation regimes	Giza 168	50	13.727	13.284	13.506
		70	14.110	14.084	14.097
		90	15.517	15.250	15.384
	Mean		14.452	14.205	14.329
	Sakha 94	50	17.602	15.574	16.588
		70	19.535	16.416	17.976
		90	20.561	17.377	18.969
	Mean		19.233	16.455	17.844
	Gemmeiza 9	50	14.457	14.266	14.362
		70	15.338	14.850	15.094
		90	16.087	17.247	16.667
	Mean		15.294	15.455	15.374
L.S.D. 0.05	Irrigations (a)		1.080	1.178	
	Cultivars (b)		0.853	n.s	
	N- rates (c)		0.554	0.757	
	(a x b)		n.s	n.s	
	(a x c)		n.s	n.s	
	(b x c)		n.s	n.s	
	(a x b x c)		n.s	n.s	

n.s. = Not significant

Table 6: Water applied, water productivity and Nitrogen use efficiency for the adopted wheat cultivars and N-rates under farmer's and corrugation irrigation practices in 2007/08 and 2008/09 growing seasons.

Irrigation practices	Water applied (mm)	Wheat cultivars	N -rate (Kg N / fed)	WP*	NUE**	Water applied (mm)	Wheat cultivars	N -rates (kg N /fed)	WP*	NUE**
		2007/2008 season					2008/2009 season			
Farmer practice	470	Giza 168	50	4.05	37.65	485	Giza 168	50	4.18	40.56
			70	4.15	27.84			70	4.26	29.53
			90	4.67	24.40			90	4.38	23.62
		Average		4.29	29.96		Average		4.27	31.24
		Sakha 94	50	5.42	50.93		Sakha 94	50	4.24	41.15
			70	5.97	40.08			70	4.59	31.80
			90	6.18	32.29			90	5.12	27.61
		Average		5.86	41.10		Average		4.65	33.52
		Gemmeiza 9	50	4.66	43.81		Gemmeiza 9	50	4.07	39.53
			70	4.82	32.93			70	4.44	30.74
			90	5.00	26.14			90	5.37	28.94
		Average		4.83	34.29		Average		4.63	33.07
Deficit irrigation, corrugation practice	401	Giza 168	50	5.51	44.71	406	Giza 168	50	4.82	39.14
			70	5.63	32.63			70	5.32	30.83
			90	6.06	27.32			90	6.03	27.22
		Average		5.73	34.89		Average		5.39	32.40
		Sakha 94	50	6.73	45.68		Sakha 94	50	6.44	52.29
			70	7.52	43.64			70	6.65	38.55
			90	8.03	36.25			90	6.72	30.31
		Average		7.43	41.86		Average		6.60	40.38
		Gemmeiza 9	50	5.29	42.94		Gemmeiza 9	50	5.67	46.07
			70	5.75	33.35			70	5.67	32.91
			90	6.09	27.49			90	6.33	28.55
		Average		5.71	34.59		Average		5.89	35.84

* Water productivity (kg grain/fed/mm) of water applied.

** Kg grain/kg of N applied

be attributed to optimizing applied irrigation water and improving the effective root zone environment, as well, under corrugation irrigation practice.

Water productivity values were higher with Sakha 94 cultivar, regardless of the adopted irrigation practices and N-rates. The percentages increase in WP for Sakha 94 cultivar, as compared to Giza 168 and Gemmeiza 9 cultivars, comprised 32.73 and 26.19 and 16.56 and 7.03, in the first and second seasons, respectively. Such findings might be attributed to the varietal differences.

Data concerning WP, as influenced by the assessed N- rates, regardless of irrigation practices and wheat cultivars, show that increasing N-rate, gradually, enhanced WP value as N-rate was increased to 70 and 90 kg /fed, as WP was increased to 6.82 and 13.83% and 5.31 and 15.10% in the first and second seasons, respectively, compared with that under 50 kg N/fed rate in the first and second seasons. Such trend was previously reported by Mechergui *et al.*(1989) with both barley and bread wheat crops. El- Sharkawy, Amal *et al.* (2006), also, found that increasing N-rate was accompanied with increases in water utilization efficiency values for maize crop. Concerning interaction effect, data revealed that the highest WP figure was recorded for Sakha 94 cultivar when received 90 kg N/fed under corrugation practice, and such findings were true in the two seasons of study.

7- Nitrogen use efficiency (NUE):

Nitrogen use efficiency (NUE) parameter quantified, in the present study, the total resultant wheat grain yield due to applying the unit of N in urea fertilizer form. Regardless of wheat cultivars and N- rates, NUE values were higher by 5.67 and 11.04% under corrugation practice, in the first and second seasons, respectively, compared with farmer's irrigation practice (Table 6). Data, also, indicated that Sakha 94 cultivar seemed to produce higher NUE value than Giza 168 and Gemmeiza 9 cultivars. The percentages increase in NUE, for Sakha 94 cultivar over those for Giza 168 and Gemmeiza 9 cultivars, were 27.91 and 20.44, in the first season, and 16.12 and 7.23 in the second one. These results might be attributed to the varietal differences.

As for the effect of the adopted N-rates on NUE character, regardless of irrigation practices and wheat cultivars, data reveal that NUE value tended to decrease as the N-rate increased. The NUE values were decreased by 20.79 and 34.66%, in the first season, and by 24.88 and 31.86 in the second season, with 70 and 90 kg N/fed rates, respectively, compared with 50 kg N/fed one. These results could be justified as the increase in grain yield was not proportional with the increase in N-rate. Such finding was previously reported by Othman, Sanaa and EL-Sharkawy, Amal (2006) with faba bean. With respect to the interaction influence, data illustrated that Sakha 94 cultivar still exhibited the highest NUE value when received 50 kg N/fed under corrugation practice in the first and second seasons of study.

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الملخص العربي

استجابة محصول الحبوب وبعض مكوناته وإنتاجية مياه الري وكفاءة استخدام النتروجين لبعض أصناف قمح الخبز لمعدل التسميد النتروجيني تحت اسلوب الري الناقص (الري بالأخاديد الضيقة) في أراضي وسط الدلتا

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أقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بالجميزه (وسط دلتا نهر النيل) في موسمي شتاء ٢٠٠٧/٢٠٠٨ - ٢٠٠٨/٢٠٠٩. وكان الغرض من الدراسة معرفة استجابة بعض أصناف قمح الخبز (جيزة ١٦٨ وسخا ٩٤ وجميزه ٩) لمعدلات التسميد النتروجيني وهى ٥٠ و٧٠و ٩٠ كجم نتروجين/الفدان تحت ظروف أسلوب الري الناقص (الري بالاخاديد الضيقة) مقارنة برى المزارع العادي. اختبرت المعاملات باستخدام التصميم الاحصائي القطع المنشقة مرتين في ثلاث مكررات حيث احتل اسلوبا الري القطع الرئيسة ، واحتلت القطع التحت منشقة أصناف القمح ، بينما خصصت القطع المنشقة مرتين لمعدلات التسميد الازوتي. ويمكن إيجاز أهم النتائج كما يلي:

١. بغض النظر عن كل من أصناف القمح ومعدلات التسميد النتروجيني تحت الدراسة ، أدي الري بالاخاديد الضيقة إلي زيادة معنوية في محصول الحبوب وصلت إلي ٨,٩٦ و ١٠,٤٧% ، مقارنة بري المزارع العادي. وعلاوة علي ذلك، تحسنت قيم مكونات محصول الحبوب (عدد السنابل/المتر المربع وعدد الحبوب في السنبلة ووزن الألف حبة) تحت ظروف الري بالأخاديد عنها مع الري العادي وذلك في موسمي الزراعة. كما أدي الري بالأخاديد الضيقة إلي توفير في كمية مياه الري المضافة للحقل وصلت إلي ١٧,٢١ و١٦,٢٩% في موسمى الزراعة ، مقارنة بري المزارع العادي وتحسنت قيم إنتاجية المياه وكفاءة استخدام النتروجين مع ظروف الري بالأخاديد. ويمكن ارجاع التحسن في قيم الصفات المذكورة إلي قدرة نظام الري بالأخاديد في إنتظام توزيع الرطوبة الأرضية علي مستوي الحقل وفي منطقة الجذور الفعالة، وبالتالي تعظيم الإستفادة من الرطوبة الآرضية والأسمدة المضافة مما ينعكس بالطبيعة علي محصول الحبوب النهائي.

٢. بغض النظر عن كل من اسلوبي الري ومعدلات التسميد النتروجيني تحت الدراسة ، ازداد محصول الحبوب معنويا مع الصنف "سخا ٩٤" مقارنة مع الصنفين "جيزة ١٦٨ وجميزه ٩" وسجل نفس الاتجاه مع صفة عدد السنابل/ المتر المربع وذلك في موسمي الدراسة. وأظهر الصنف "جميزه ٩" أعلى قيم لصفتي عدد الحبوب في السنبلة ووزن الألف حبة مقارنة مع الصنفين "جيزة ١٦٨ وسخا ٩٤".

٣.بغض النظر عن كل من اسلوبي الري وأصناف القمح تحت الدراسة ، أدت زيادة معدل التسميد النتروجيني إلي زيادة معنوية في محصول الحبوب ومكوناته وذلك في موسمي الدراسة. وتحسنت قيم انتاجية المياه مع زيادة معدل التسميد النتروجيني ، وسجل العكس تماما لقيم كفاءة استخدام النتروجين.

لم يكن للتفاعلات المختلفة تأثيرا معنويا علي محصول الحبوب ومكوناته في موسمي الدراسة ، ومع ذلك، أظهر الصنف "سخا ٩٤ " قيما عالية لمحصول الحبوب وصفة عدد السنابل بالمتر المربع مع التسميد بمعدل ٩٠ كجم نتروجين/ الفدان تحت نظام الري بالاخاديد الضيقة. وأظهر كل من الصنفين "سخا ٩٤ وجميزه ٩" قيما عالية لصفتي عدد الحبوب بالسنبلة ووزن الألف حبة وذلك مع التسميد بمعدل ٩٠ كجم نتروجين/ الفدان تحت نظام الري بالاخاديد الضيقة.