Journal of Applied Sciences Research, 8(5): 2776-2784, 2012
ISSN 1819-544X
This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLES

Effect of deficit irrigation on some growth stages of wheat

Abd El-Ghany, H.M., M.S. Abd El-Salam, M. Hozyen and M.H.M. Afifi

Field Crops Res. Dept. National Research Centre, Giza, Egypt.

ABSTRACT

A split plot arrangement used in tow complete factorial design field experiments which was conducted during 2009/2010 and 2010/2011 successive winter seasons in a clay loam soil at a special farm, to represent the soil of Nile delta, Gharbiya Governorate, Egypt. To investigate the effect of irrigation and evaluate the production of three local varieties of wheat (*Triticum aestivum* L) *i.e.*, Gemmieza 7, Giza 164, and Sakha 93 under water deficit conditions during tillering and flowering growth stages, which of these growth stages more affected by water scarcity and studying the influence of the water regimes on growth, yield and yield components characters. Results indicated that, the water deficit imposed at the tillering stage reduced significantly the growth traits, while yield and its components were affected by water scarcity during flowering stage more than it's affected during tillering growth stage. Withholding irrigation during tillering and/or flowering growth stages reduced significantly all vegetative growth, yield and yield components studied characters more than under normal irrigation. The maximum effect on reducing grain yield production was obtained by the application of the interaction between I_2 (skipping one irrigation at tillering stage) and variety sakha 93.

***Key words*:** deficit irrigation, growth, yield and wheat.

Introduction

Wheat *(Triticum aestivum L.)* is the most widely grown cereal crop in the world. Moreover; it has been considered the first strategic food crop. It is the main diet for the Egyptian population. Wheat is the main winter cereal crop and is widely distributed all over the country and the mean production of wheat in Egypt in the Valley and Delta regions about 18.18 ardab/fed. (one ardab = 150 kg and one faddan = 4200m^2). The country imported about 55% of the total consumption of wheat about 5.4 million ton (2010 year). Therefore, increasing wheat production becomes an important national goal to reduce the gab between wheat production and food consumption, as well as, reduce wheat imports and save foreign currency. It was anticipated that high and stable wheat yield could be achieved by applying the most favorable cultural practices.

The magnitude of yield reduction from water deficits in wheat depends upon the growth stage at which the water deficiency. Several studies indicated that wheat grain yield shows high response to water supply and deficiency (Ashraf, 1998, Sharaan *et al.*, 2000, Abo-Warda, 2002, Osborne *et al.*, 2002 and Abd El-Ghany, 2003, Kassab and EL-Zeiny, 2005, Nouri-Ganbalani *et al*., 2009). In addition, several workers indicated that irrigation regimes had negative significant effect on yield attributes (Mohmed, 1999, Sharaan *et al.*, 2000, Abd El-Ghany, 2003, Hassan, 2003, Kassab *et al*., 2004, Kassab and EL-Zeiny, 2005 and Nouri-Ganbalani *et al*., 2009. Several studies indicated that significant wheat Varietal differences regarding growth, flowering, yield attributes and grain yield (EL-Helaly, 1984, Rady and Abo El-Zahab, 1990, Abd El-Khalek, 1991, Shalaby *et al*., 1993, Abd El-Moneim, 1999, Mahmoud, 1999, Sharaan *et al*., 2000, Ibrahim *et al*., 2004, Mirbahar *et al*., 2009, Maralian *et al*., 2010 and Moharram and Habib, 2011).

The aim of the present investigation was to share in solving the problem of the low productivity of wheat grain yield under water deficit by testing the yield of the some commercial varieties and determining the proper irrigation levels to obtain maximum yield. In addition, this investigation may help wheat breeder to get information on the important plant characters influencing wheat yield.

Therefore, three wheat cultivars were grown under three levels of irrigation at a special farm, to represent the soil of Nile delta, Gharbiya Governorate, Egypt to determine the influence of water regime treatments on growth, yield and yield components characters and to evaluate the production of local wheat varieties under the irrigation deficit conditions.

Corresponding Author: Abd El-Ghany, H.M., Field Crops Res. Dept. National Research Centre, Giza, Egypt.

J. Appl. Sci. Res., 8(5): 2776-2784, 2012

Materials and Methods

The present investigation was carried out during the two successive seasons of 2009/2010 and 2010/2011 at a special farm, to represent the soil of Nile delta, Gharbiya Governorate, Egypt. To investigate the effect of irrigation and evaluate the production of three local varieties of wheat (*Triticum aestivum* L) under water deficit conditions during tillering and flowering growth stages. Each experiment in each year included nine treatments which were the combination of three levels of irrigation (Table 1) and three wheat varieties as follows:

A- Irrigation regime:

1- Completely five irrigations (I_1)
2- Skipping one irrigation at tillering stage (I_2)
3- Skipping one irrigation at flowering stage (I_3)

Table 1: Irrigation scheduling in 2009/2010 and 2010/2011 seasons.

Season	Irrigation levels	Sowing date	Irrigations				
			1st	2nd	3rd	4th	5th
1st season 2009/2010	(I_1) (I_2) (I_3)	21/11/2009	14/12/2009	11/1/2010 -------- 11/1/2010	10/2/2010	12/3/2010 12/3/2010 --------	11/4/2010
2nd season 2010/2011	(I_1) (I_2) (I_3)	23/11/2010	17/12/2010	15/1/2011 -------- 15/1/2011	14/2/2011	13/3/2011 13/3/2011 --------	12/4/2011

B- Varieties:

Gemmieza 7, Giza 164, and Sakha 93 were obtained from the wheat research department, Field Crops Research Institute, Agricultural Research Center (ARC), Giza, Egypt.

The soil of the experiment field was clay loam in texture. The preceding crop was maize in both seasons. A Randomize Complete Block Design in a split plot arrangement with three replications was used in both seasons. Irrigation regime levels were randomly allocated to the main plots; while wheat varieties occupied the sub-plots. The sub-plots area was 12 m^2 (4 m width and 3 m length). Calcium superphosphate (15.5%) was applied during soil preparation at the rate of 15.5 kg/fed (P_2O_5). Seeds were hand drilled in nineteen rows 20 cm apart at a rate of 60 kg/fad Sowing was done on 21st and 23rd November in the first and second seasons, respectively. Nitrogen fertilizer was applied in the form of ammonium nitrate (33.5% N) in two equal doses before the first irrigation (21 days after sowing) and before the second irrigation (42 days after sowing). The normal cultural practices of growing wheat were performed.

Studied characters:

I. Growth and flowering characters:

Samples of five competitive plants randomly taken from the second inner rows of each sub-plot at 120 days after sowing to determine the following growth attributes:
1- Plant height (cm). 2- Blade flag leaf area (cm^2). 3- Number of days from planting to 50% heading.

II- Yield and its components:

At harvest, twenty spikes were taken at random from the inner rows in each sub-sub plot to estimate 1 - 4 and 6 traits while one m^2 was taken to estimate traits number 5 and 7 - 9:

1- Spike length (cm).	2- Number of spikelets/spike.
3- Number of grains/spike.	4- Number of grains/spikelet.
5- Number of spikes/m^2	6- 1000-grain weight (g).
7- Grain yield (ardab/feddan).	8- Straw yield (ton/fed.).
9- Harvest index (%).	

Statistical procedures:

The obtained data were subjected to regular statistical analysis of variance as well as differences between means of genotypes were tested for significant against LSD values at 5% level of probability in both seasons according to (Snedecore and Cochran 1990). In addition, the homogeneity of error test for two seasons was not

significant (Bartlett 1937). Thus, a combined analysis was done. The MSTAT computerized package program was subjected to the regular statistical analysis of variance (Nissen *et al*., 1985).

Results & Discussion

A- Effect of irrigation levels:

I- Growth and flowering characters:

Some of growth and flowering characters of wheat varieties under three levels of irrigation and all combination of their interactions. The analysis of variance of data showed that, the three irrigation levels had significant effect on plant height and days to 50% heading in both seasons and their combined. While the blade flag leaf area was significantly affected in the first season only, while was not significantly affected in the second season and their combined as shown in Table (2).

Table 2: Effect of number of irrigations on some growth and flowering characters of wheat during 2009/2010 and 2010/2011 seasons and its combined.

Character / Irrigation	Plant height (cm)			Blade flag leaf area (cm^2)			Days to 50% heading		
	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
I_1	114.48	113.94	114.21	49.24	49.08	49.16	86.89	86.84	86.86
I_2	113.33	113.14	113.24	49.16	49.11	49.13	86.67	86.73	86.70
I_3	113.67	113.61	113.64	49.10	49.02	49.06	86.73	86.78	86.76
F test	*	*	*	*	ns	ns	*	*	*
LSD at 5%	1.00	0.62	0.80	0.10	--	--	0.14	0.10	0.12

Regarding to the combined mean, the tallest plant (114.21 cm.) was obtained from the high level of irrigation (five irrigations), while the shortest plant (113.24 cm.) was recorded by the low level of irrigation (skipping one irrigation at tillering stage). The decrease in plant height could be due to the effect of water stress in tillering and elongation stages. Moreover the increase in plant height may be due to the effect of water on cell size through cell enlargement and turgidity. Similar results were recorded by Mohamed (1999), Hassan (2003) and Kassab and EL-Zeiny (2005). The largest blade flag leaf area (49.16 cm^2) was recorded by the high level of irrigation (five irrigations), while the lowest value of blade flag leaf area was (49.06 $cm^{2)}$ by skipping one irrigation at flowering stage. Generally, the results indicated that the blade flag leaf area decreased gradually with decreasing irrigation levels from five to four irrigations. This could mainly be due to the effect of water on function of two physiological processes; the first is increasing number of cells through cell division and the second is increasing cell size through cell elongating and turgidity. These results are in a good agreement with those obtained by Shalaby *et al.,* (1993) and Mahmoud (1999). The highest value of days to 50% heading was (86.86 days) which obtained from the high level of irrigation (five irrigations), while the lowest value (86.70 and/or 86.76 days) was obtained from the low level of irrigation (four irrigations). These results revealed that the reduction of irrigation level during either tillering or flowering stage pushed the plants towards rapid heading and decreased the period of vegetative growth. Similar results were obtained by Mohamed (1999).

II- yield and yield components characters:

The analysis of variances data of the two growing season's experiments and its combined data revealed that, the three irrigation levels had a highly significant effect on all yield and yield components characters under this study in both seasons and their combined except few cases were only significant affected *i.e*., spike length, number of spikelets/spike, number of grains/spike, 1000-grain weight and grain yield ardab/fed. in the 2009/2010 season and 1000-grain weight in the combined data of two seasons.

Data in Table (3) showed that the tallest spike (12.93 cm.) was recorded under the high levels of irrigation (five irrigations); while the shortest spike (10.50 cm.) was obtained from the low level of irrigation (skipping one irrigation at tillering stage). These increases by completely irrigations may be attributed to the role of water on cell size and cell elongation through the plant stages. These results are in general agreement with these obtained by Mahmoud (1999), Sharaan *et al*., (2000) and Malik and Hassan (2001). The highest number of spikelets per spike (23.93) was recorded when completely irrigations were applied, while, the lowest number (21.24 spikelets) was recorded at skipping one irrigation at flowering stage. These increases may be due to the increases in spike length and the role of water on cell elongation (Mahmoud 1999). The high level of irrigation (I_1) gave the highest value of number of grains/spike (67.77), while, the low level of irrigation (I_3) gave the lowest value (58.95). Increasing number of grains per spike maybe attributed to the increase in spike length and increasing number of spikelets per spike as well as increasing fertile flowers per spikelet. These results supported by Mohamed (1999), Sharaan *et al.,* (2000), Abo-Warda (2002) and Hassan (2003). The highest value

(2.83 grains/spikelet) was obtained from the high level (five irrigations), while, the low level (skipping one irrigation at tillering stage) gave the value of (2.50 grains/spikelet). This may be due to the decreasing of fertile flowers per spikelet as affecting by water deficit (Mahmoud 1999). The highest number of spikes/m^2 (482.08) was obtained from the high level of irrigation (I_1), while, the lowest number of spikes/m^2 (372.11) obtained when skipping one irrigation at tillering stage. The decrease in number of spikes/m^2 with exposing plant to drought may be due to the decrease in number of tillers/plant as affecting by water sacristy during tillering stage. These results are agreement with those reported by Mohamed (1999), Sharaan *et al.,* (2000) and Abo-Warda (2002). The highest value of 1000-grain weight (46.32 g.) was obtained from the high level of irrigation (I_1), while the lowest value of (44.54 g.) recorded when irrigated with the low level (I_3). Exposing wheat plants to drought during its life might cause a reduction in photosynthesis accumulation which caused a reduction in yield attributes. These results are similar with those obtained by Sharaan *et al.*, (2000) and Kassab and EL-zeiny (2005). The skipping one irrigation at tillering and at flowering stages caused a reduction in grain yield and gave the value of (16.36 and 15.65 ardab/fed. as a combined data), respectively. While, the increase in grain yield was given when the plants grown under completely irrigation and gave the value of (18.82 ardab/fed.). Exposing wheat plants to water stress caused a reduction in grain yield/fed., this reduction attributed to the reduction in number of spikes/m^2, spike length, number of spikelets/spike and 1000-grain weight. These results are in harmony with those obtained by Hassan (2003) and Kassab *et al*., (2004). The highest value for straw yield per faddan was 4.28 ton which obtained from the high level of irrigation (I_1) while the low level of irrigation (I_2) caused a reduction in this trait and gave the value of (3.46 ton). These results may be due to the increase in number of tillers/m^2 and plant height. Similar results were obtained by Mohamed (1999), Sharaan *et al.,* (2000), Kassab *et al*., (2004) and Kassab and EL-Zeiny (2005). The highest value for harvest-index (41.97 %) was obtained from the low level of irrigation (I_2) while the low level (I_3) gave the lowest value (36.39%). Similar results were obtained by Mahmoud (1999), Sharaan *et al*., (2000) and Kassab and EL-Zeiny (2005).

Table 3: Effect of number of irrigations on yield and some its components characters of wheat during 2009/2010 and 2010/2011 seasons and it's combined.

Character	Spike length (cm)			No. of spikelets/spike			No. of grains/spike		
Irrigation	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
I_1	12.93	12.45	12.69	23.93	23.50	23.72	67.77	67.43	67.60
I_2	10.50	10.84	10.67	22.06	22.71	22.38	60.64	61.17	60.91
I_3	11.03	10.68	10.86	21.72	21.24	21.48	59.39	58.95	59.17
F test	*	**	**	*	**	**	**	**	**
LSD at 5%	0.29	0.24	0.27	0.32	0.26	0.29	3.93	3.25	3.54
Character	No of grains/spikelet			No. of spikes/m^2			1000-grain weight (g)		
Irrigation	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
I1	2.83	2.63	2.73	482.08	481.44	481.76	46.32	45.92	46.16
I2	2.71	2.50	2.61	372.11	372.43	372.27	45.33	45.90	45.62
I3	2.73	2.58	2.66	387.30	385.95	386.62	44.87	44.54	44.70
F test	*	**	**	**	**	**	*	**	*
LSD at 5%	0.08	0.06	0.07	13.90	14.50	14.00	1.35	1.28	1.32
Character	Grain yield (ard/fed.)			Straw yield (ton/fed.)			Harvest Index (%)		
Irrigation	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
I_1	18.99	18.65	18.82	4.28	4.16	4.22	39.96	40.21	40.08
I_2	16.03	16.68	16.36	3.52	3.46	3.49	40.59	41.97	41.29
I_3	15.79	15.5	15.65	4.14	3.87	4.01	36.39	37.53	36.92
F test	*	**	**	**	**	**	**	**	**
LSD at 5%	2.95	2.29	2.59	0.46	0.33	0.39	4.76	3.41	3.95

B- Varietal differences:

I- Growth and flowering characters.

Significant differences could be detected from analysis of variance among the tested wheat varieties regarding to their growth and flowering characters during the first, second seasons and its combined data.

The tallest variety was Giza 164 which gave the highest value (121.74 cm), whereas, the shortest variety was Sakha 93 which gave the lowest values (99.35 cm), see Table 4. In this respect, Abd El-Ghany, 2003 and Ibrahim *et al.,* (2004). The highest value of blade flag leaf area (53.01 cm^2) was obtained by the variety Gemmieza 7, while, the lowest value (47.02 cm^2) was obtained by the variety Sakha 93 the variation between wheat genotypes in blade flag leaf area may be due to the heretical variation of them in this respect, Abd El-Khalek (1991) Shalaby *et al.,* (1993), and Mahmoud (1999).

Average of both seasons ranged from 84.94 to 87.77 days from planting to 50% heading. The earliest variety was Giza 164 whereas; the latest genotype was Gemmieza 7. The last variety occupied a medium position; these results attributed to their genetic background which played the major role in this respect the variation in 50% heading among wheat varieties were recorded by several researchers *i.e.*, Abo-Warda (2002), Abd El-Ghany (2003) and Ibrahim *et al.,* (2004).

Table 4: Varietial mean performance for growth and flowering characters of wheat during 2009/2010 and 2010/2011 seasons and its combined.

Character / Variety	Plant height (cm)			Blade flag leaf area (cm^2)			Days to 50% heading		
	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
Sakha 93	99.79	99.35	99.57	47.13	47.02	47.07	87.54	87.56	87.55
Giza 164	121.74	121.54	121.64	47.34	47.21	47.27	84.94	84.94	84.94
Gemmeiza 7	120.11	119.95	120.03	53.03	52.98	53.01	87.76	87.78	87.77
F test	*	*	*	*	*	*	*	*	*
LSD at 5%	2.50	2.00	2.30	5.00	4.10	4.66	2.02	1.89	1.90

II- yield and yield components characters:

Significant and/or highly significant differences could be detected from analysis of variance among the tested wheat varieties regarding to their all yield and some of its components characters during the first, second seasons and its combined data. While there was no significant differences among wheat varieties to their number of grains per spikelet in the combined data of the two seasons

Combined of two seasons data in Table (5) showed that, the Gemmieza 7 cultivar (12.62 cm.) exceeded the other varieties for spike length. The highest number of spikelets/spike (24.07) was obtained from Gemmieza 7 cv. These results were agreement with those obtained by Abo-Shataia *et al.,* (2001) and Ibrahim *et al.,* (2004). The highest value of number of grains/spike (67.90) was obtained by Gemmieza 7 variety. The differences in number of grains/spike due to wheat genotypes could be due to their variation in genetically composition and also in spike length. Similar results were reported by Abo-Shataia *et al.,* (2001). The highest number of grains/spikelet (2.72) was obtained from Gemmieza 7 cv. followed by Giza 164 then Sakha 93 which gave the values of (2.67 and 2.61), respectively, with no significant between them. Similar results were obtained by Abo-Shataia *et al.,* (2001). The highest number of spikes/m^2 (433.80) was obtained from Giza 164 cv. These differences in number of spike/m^2 among wheat varieties may be due to the genetic variations. Similar conclusions were reported by Sharaan *et al.,* (2000) and Abd El-Ghany (2003). The highest mean values in 1000-grain weight (46.54) were obtained by Gemmieza 7 cv. The differences in 1000-grain weight for wheat genotypes may be attributed to the great size of the genotypes. Similar results obtained by Mahmoud (1999), Abd El-Ghany (2003), Kheiralla *et al*., (2004) and Mirbahar *et al*., (2009).

The highest value of grain yield/fed (17.60 ardab) was obtained from Gemmieza 7 cv. over the combined of both seasons; followed by the cultivars; Giza 164 and Sakha 93 (16.70 and 16.53 ardab), respectively, with no significant between the latest varieties. These results may be due to the increasing of spike length, number of spikelets/spike, number of grains/spike, and 1000- grain weight for the Gemmieza 7 cultivar. The highest value of straw yield/fed. (4.32 ton) was obtained from the cultivar Giza 164, while the lowest value (3.39 ton) was obtained from the cultivar Gemmieza 7. This superiority or deficiency in straw yield/fed. may be attributed to number of spikes/m^2 (as indicator to number of tillers/m^2). These results were agreement with those obtained by Rady and Abo El-Zahab, 1990, Abo-Shataia *et al*., (2001), Abd El-Ghany 2003 and Ibrahim *et al*., 2004. It is interesting to note that the parameter of harvest index which indicated the efficiency of a cultivar to contribute for the economic yield was higher in the high yielding variety than the lower yielding one. The highest value of harvest index (43.78 %) was obtained from Gemmieza 7 While, the lowest value (36.69 %) were obtained from Giza 164 in the combined data of the two growing seasons. These differences may be attributed to their differences in grain and straw yields/fed. These findings were agreement with those recorded by Rady and Abo El-Zahab, 1990, Abd El-Moneim, 1999, Abo-Warda, 2002 and Kheiralla *et al*., 2004.

Table 5: Varietial mean performance for yield and some its components characters of wheat during 2009/2010 and 2010/2011 seasons and its combined.

Character / Variety	Spike length (cm)			No. of spikelets/spike			No. of grains/spike		
	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
Sakha 93	11.11	11.09	11.10	22.02	22.09	22.06	60.03	60.11	60.07
Giza 164	11.52	10.46	10.49	21.41	21.49	21.45	59.65	59.74	59.70
Gemmeiza 7	12.84	12.42	12.62	24.27	23.86	24.07	68.10	67.70	67.90
F test	*	*	*	*	*	*	**	**	**
LSD at 5%	1.19	1.06	1.10	1.57	1.02	1.30	2.66	2.39	2.49
Character / Variety	No of grains/spikelet			No. of spikes/m2			1000-grain weight (g)		
	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
Sakha 93	2.72	2.50	2.61	417.37	416.18	416.77	45.70	45.79	45.74
Giza 164	2.75	2.58	2.67	433.83	433.77	433.80	44.14	44.23	44.19
Gemmeiza 7	2.80	2.63	2.72	390.29	389.88	390.09	46.75	46.34	46.54
F test	*	*	ns	**	**	**	**	**	**
LSD at 5%	0.09	0.10	--	20.00	17.00	18.40	1.40	1.10	1.20
Character / Variety	Grain yield (ard/fed.)			Straw yield (ton/fed.)			Harvest Index (%)		
	1st	2nd	Com	1st	2nd	Com	1st	2nd	Com
Sakha 93	16.43	16.63	16.53	4.09	3.93	4.01	37.62	38.82	38.21
Giza 164	16.59	16.80	16.70	4.38	4.26	4.32	36.22	37.16	36.69
Gemmeiza 7	17.80	17.41	17.60	3.48	3.30	3.39	43.44	44.16	43.78
F test	**	**	*	**	**	**	**	**	**
LSD at 5%	0.89	1.09	0.91	0.19	0.17	0.18	3.10	3.00	3.05

C- Combined interaction between irrigation levels and wheat varieties:

I- Growth and flowering characters:

The interaction between irrigation levels and tested wheat varieties had a significant and/or highly significant effect on plant height, blade flag leaf area and days to 50% heading in the first and/or second season and their combined. The highest value (122.32 cm) was obtained from variety Giza 164 grown under five irrigations (I_1); the highest value (53.68 cm^2) was obtained by the variety Gemmieza 7 under five irrigations and the highest value (87.84) was reported by Gemmieza 7 under the higher level of irrigation (five irrigations) for the previous traits, respectively. Similar results were obtained by Sharaan *et al.,* (2000), Abo-Warda (2002), Abd El-Ghany, (2003) and Ibrahim *et al.*, (2004).

II- yield and yield components characters:

The analysis of variance of interaction between irrigation levels and wheat genotypes for yield and its components under study was a significant for spike length in the combined of the two seasons, had a significant and/or highly significant effect on yield and its components characters in the first and/or second seasons and the combined of two seasons.

The mean performance values of this interaction for the yield and its components characters showed that the greatest value of spike length (13.75 cm.) was obtained by the genotype Gemmeiza 7 under five irrigations. The highest value of number of spikelets/spike (24.72) was obtained by Gemmeiza 7 under five irrigations. Khieralla *et al*., (2004) revealed that irrigation and genotypes interaction had a significant effect on number of grains per spike and so Abo-Warda (2002) and Abd El-Ghany (2003)**.** The highest value (74.13 grains/spike) was obtained from genotype Gemmieza 7 with five irrigations. The highest value (3.00 grains per spikelet) was obtained from Gemmieza 7 under five irrigations. The highest number of spikes/m^2 (500.91 spikes) was obtained by the genotype Giza 164 under five irrigations. Several researchers came to the same results such as Abo-Warda (2002), Abd El-Ghany (2003) and Khieralla *et al*., (2004). The highest value of 1000-grain weight (48.48 g) was obtained from the genotype Sakha 93 with five irrigations. Abo-Warda, 2002, Abd El-Ghany, 2003 and Khieralla *et al*., 2004 indicated that irrigation and genotypes interaction had a significant and/or highly significant effect on 1000-grain weight**.** The highest value (19.16 ardab per faddan) was reported by the genotype Gemmieza 7 with five irrigations. The highest value (4.68 ton per faddan of straw yield) was obtained from Sakha 93 with five irrigations. Because the graph equal one thousand words, we can summarized the all combination of the interaction in Fig. 1.

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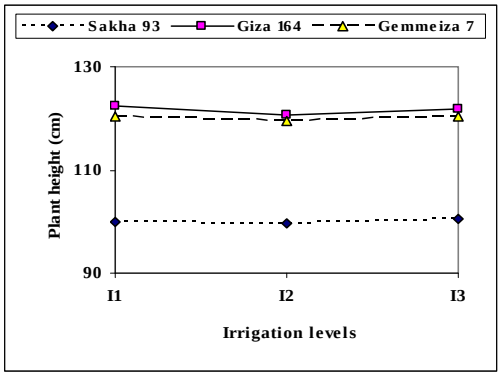

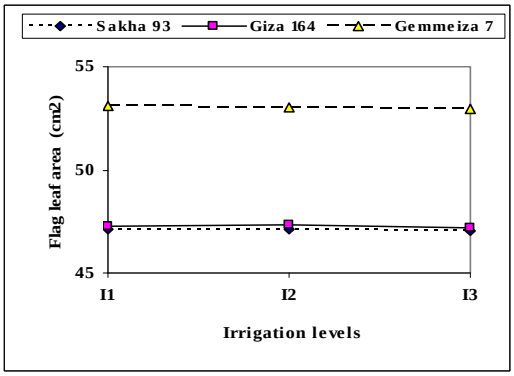

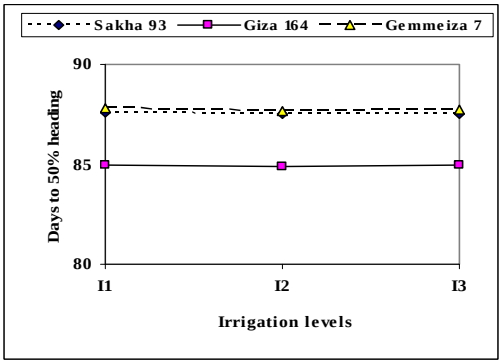

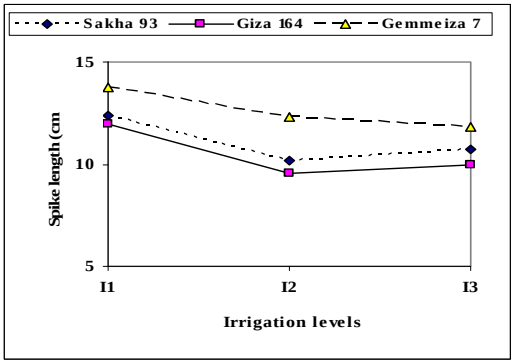

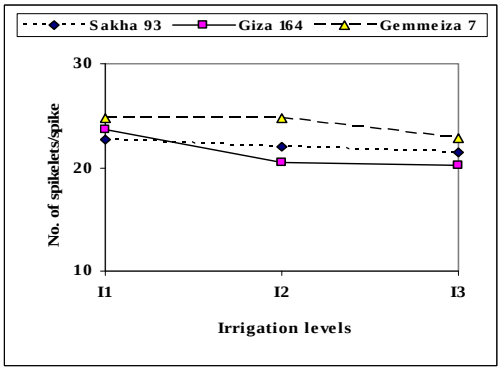

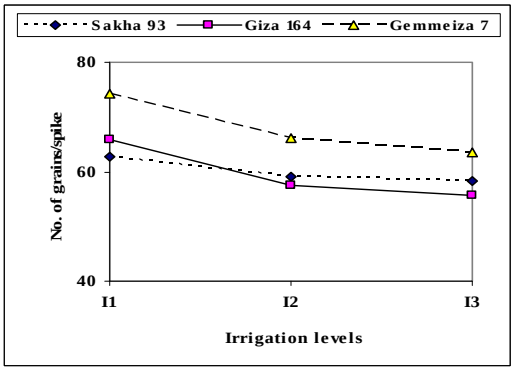

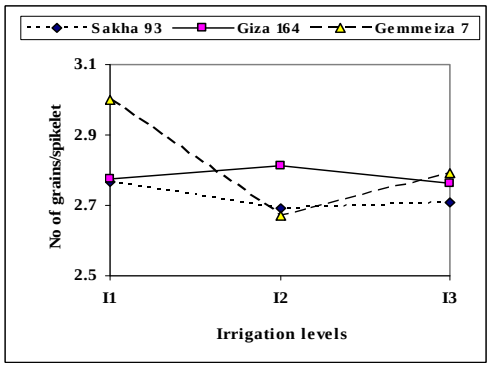

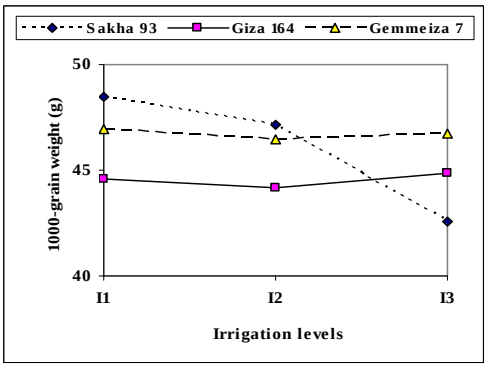

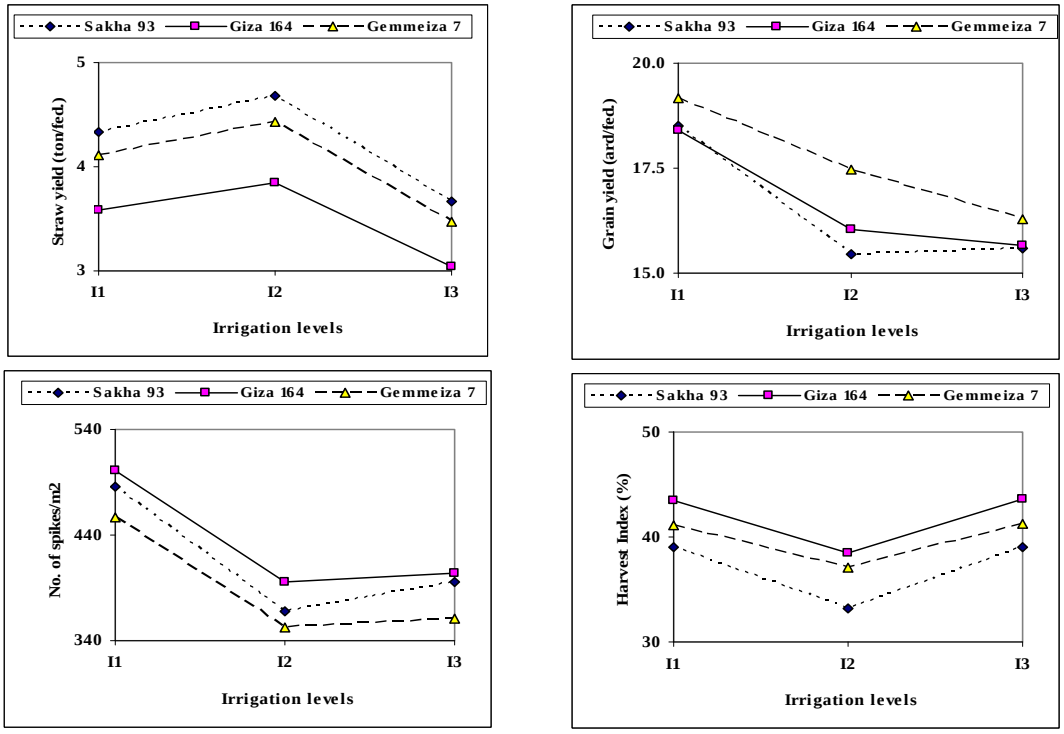

Fig. 1: Combined interaction between irrigation levels and wheat varieties for all studied characters.

In general, from the previous results it could be concluded that, the studied varieties has varied significantly and/or highly significantly among them due to applying the irrigation treatments. The maximum effect on reducing grain yield production was obtained by the application of the interaction between I_2 (skipping one irrigation at tillering stage) and variety sakha 93. The effects of water deficiency on different wheat characters were also reported by nemours researchers, for grain yield and some of its components, Mahmoud, 1999, Sharaan *et al*., 2000, Ibrahim *et al*., 2004, Abo-Warda, 2002 and Abd El-Ghany, 2003, Mirbahar *et al*., 2009, Maralian *et al*., 2010 and Moharram and Habib, 2011. They suggested that grain yield and its attributes were markedly reduced when the plants were subjected to water stress.

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