Journal of Agri-Food and Applied Sciences
Available online at jaas.blue-ap.org
©2014 JAAS Journal. Vol. 2(9), pp. 275-282, 30 September, 2014
E-ISSN: 2311-6730

Effect of Different Irrigation Regimes on Grain Yield and Quality of Some Egyptian Bread Wheat Cultivars

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Received: 05 August, 2014 *Accepted: 20 August, 2014* *Published: 30 September, 2014*

A B S T R A C T

Two field experiments were conducted in the successive winter seasons 2011/2012 and 2012/2013 at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University to study the effect of irrigation regime (I_1: full irrigation 5 irrigation, I_2: skipping 2nd irrigation, I_3: skipping 3rd irrigation, I_4: skipping 4th irrigation and I_5: skipping 5th irrigation) on yield and quality of five wheat cultivars (Sids 12, Gemmeiza 9, Sakha 93, Misr 1 and Misr 3). A spilt-plot in a randomized complete block arrangement design with three replications was used. Results showed that skipping irrigation at various growth stages had significant effect on days to heading, days to maturity and days from heading to maturity. Skipping the second or the third irrigation led to early heading and early maturity. Also, results showed that skipping irrigation at various growth stages significantly decreased plant height, number of tillers m^{-2}, number of spikes m^{-2}, spike length, 1000-kernel weight, grain, straw and biological yields and harvest index in both seasons. However, protein content was decreased by skipping irrigation at various growth stages compared with normal irrigation in two seasons. Among wheat cultivars, Sids 12 cultivar ranked 1st in all yield traits and protein content in both season. It concluded that Sids 12 cultivar was more tolerant for drought stress compared with other wheat cultivars in both seasons

Keywords: *Wheat, Cultivars, Irrigation regime, Skipping, Heading, Maturity, Yield, Grain quality, straw, biological, Protein.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the first most important cereal crop in Egypt and covers 1,418,708 ha of land with an annual production 9,460,200 ton, according to FAO 2013 (Anonymous, 2014). The statistics indicate that local production of wheat is not enough consumption needs and Egypt imports about 6 million tons of wheat to eliminate the gap between consumption and production of wheat. So, the Egyptian government's, make efforts to increase the productivity per unit area of wheat by devising new varieties of high productivity and low water consumption.

Kandil . (2001) studied the response of some wheat cultivars (i.e., Giza 164, Sakha 69 and Sids 1) to water stress induced by skipping irrigation either at tillering, heading and milk-ripe stages. The results showed that, plant height, no. of spikes/plant, spike length, 1000-grain weight, grain yield per plant and grain yield per faddan as well as biological yield were markedly reduced when the plants were subjected to water stress. The depressing effects of soil moisture stress were comparatively high at tillering, intermediate at heading and low at milk-ripe stage. Moreover, significant differences were observed among the tested wheat cultivars in grain yield and its attributes. Giza 164 cultivar was higher in grain yield than the two other ones. El-Sayed (2003) studied the response of Gemmeiza 9 wheat cultivar to irrigation 5, 10 and 15 days at heading and maturity in sandy soils. The results indicated that there were significant differences among irrigation treatments for plant height. Kassab . (2004) studied the effect of irrigation treatments (irrigation every 30 days and skipping irrigation at tillering, heading and milk-ripe stages) on the wheat yield and its attributes. The results revealed that skipping irrigation at any of the three studied stages significantly reduced plant height as compared with the control plants.

Saleem . (2007) studied that the effect of water regime at various growth stages on the performance of wheat production. The irrigation treatments given to four wheat varieties, were (I_0) no irrigation, by adding subsequently each with (I_1) single irrigation at germination, (I_2) two irrigations up to tillering, (I_3) three irrigations up to anthesis and (I_4) four irrigations up to milk stage. Irrigation significantly affected spikes m^{-2}, spikes weight, 1000 grain weight, days to maturity and biological and grain yields were significantly different. The interactive effect of irrigation and varieties was only affected biological and grain yield. Hence all the irrigation levels produced significant differences in yield and its components. Moreover, Banker . (2008) showed that the highest values of growth characters were obtained with five irrigations (at crown root initiation, tillering, jointing, flowering and milking stages.

Bayoumi . (2008) evaluated nine wheat genotypes; seven local varieties with two introduced genotypes from (ICARDA). The field experiment was grown under two water regimes (stress and non-stress treatments). The stress treatment induced by withholding irrigation after emergence and giving two supplementary irrigations, one after 60 days post-sowing and the other after 90 days post-sowing and non-stress (well-watered). Combined analysis of variance over two seasons showed highly significant differences among wheat genotypes in all the studied traits and water stress decreased them significant. Sarwar . (2010) studied that effect of five irrigation regime (I_1: irrigation at crown root stage, I_2: irrigation at crown root + tillering, I_3: irrigation at crown root + tillering + booting, I_4: Irrigation at crown root + tillering + booting + anthesis and I_5: Irrigation at crown root + tillering + booting + anthesis + milking) on yield and yield components of three wheat cultivars (AS-2002, SH-2002 and Aqab-2000). Wheat cultivar AS-2002 recorded highest grain yields which higher than the other two cultivars. Wheat crop supplied with five irrigations (irrigation at crown root + tillering + booting + earing + milking recorded the highest grain yield which was significantly higher than all other irrigation levels.

Seleiman . (2011) found that increasing number of irrigations up to five increased grain yield (ton ha^{-1}), biological yield (ton ha^{-1}), harvest index, number of spikes m^{-2}, number of grains/spike and 1000-kernel weight but significantly decrease protein content. Abro (2012) concluded that for obtaining maximum grain yield in wheat, the crop will need five irrigations because there was significant decrease in grain yield with decreasing the number of irrigations.

Mohamed (2013) studied that the effect of three levels of irrigation regime (T_1=2 irrigations, T_2=3 irrigations, T_3=4 irrigations and T_4=5 irrigations as control) on eight cultivars and lines. He found that Sids 12 cultivar was the highest in yield and its components and the most tolerant to drought stress compared with commercial cultivars (Sakha 93, Sakha94, Gemmeiza10 and Giza 168) and other tested lines. Grain yield, plant height, no. of kernels/spike, no. of spikes/m^2, days to heading and days to maturity were decreased with increasing drought stress. However, Protein content was increased with increasing drought stress. Zarein . (2014) reported that water stress through withholding at the ear emergence and grain filling phases reduced grain yield and its components. Also, results indicated that cultivars were significantly different in yield and its components. Due to high sensitive of Marvdasht cultivar to drought stress, grain yield and its components noticeably decreased, while WS-82-9 showed superior characteristics, therefore produced high grain values.

Aslam . (2014) concluded that among irrigation scheduling five irrigation (1^{st} 25 DAS and subsequent irrigations at 15 days intervals), produced maximum all the growth and yield traits studied particularly grain yield (6999.30kg ha^{-1}) as compared to four irrigations (1^{st} 30 DAS and subsequent irrigations at 20 days interval) and 3 irrigation (1^{st} 35 DAS and subsequent irrigations at 25 days interval). Among varieties SKD-1 gave superior performance particularly grain yield (5818.80 kg ha^{-1}) than TD-1 and Imdad. Hence SKD-1 × five irrigation interaction was found most suitable for obtaining maximum grain yield (7444.70 kg ha^{-1}) of wheat.

Keeping the importance of production of wheat crop in view, the aim of this research was to investigate effect of skipping irrigation at various growth stages on yield and quality of five Egyptian bread wheat cultivars.

MATERIALS AND METHODS

Two field experiments were conducted in the successive winter seasons 2011/2012 and 2012/2013 at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, Giza, to study the effect of five irrigation regime i.e: I_1 five irrigation (at tillering + stem elongation + booting + anthesis + ripping), I_2: skipping 2^{nd} irrigation, I_3:skipping 3^{rd} irrigation , I_4:skipping 4^{th} irrigation and I_5: skipping 5^{th} irrigation , on five wheat cultivars (Sids 12, Gemmeiza 9, Sakh93 , Misr 1 and Misr 3). A spilt plot design in a randomized complete blocks arrangement with three replications was used to conduct all trials. The five wheat cultivars were randomly assigned for main plots. The irrigation treatments were randomly arranged for main plots. The five wheat cultivars were randomly assigned for sub plots. Each plot consisted of fifteen rows, four meters long with 20 cm between rows (plot area 12 m^2). The preceding summer crop was maize in both seasons. In both seasons, the soil texture was clay loam. Super phosphate (15.5% P_2O_5) was added during soil preparation at the rate 37 kg ha^{-1} P_2O_5. Sowing was done by means single row hand drill on 15^{th} and 17^{th} May in both season, respectively. Seeding density was 350 seeds m^{-2}. Urea (46 %) was applied at rate 168 kg ha^{-1} in three equal doses, before the first and second irrigation. The phonological stages were recorded for each plot. Days to heading (days from sowing to the date when 50% of spikes emerge completely from the flag sheath), days to maturity (days from sowing to the date when 50% of peduncles turned yellow) and days from heading to maturity (by calculation: day from sowing to maturity–days from sowing to heading. At harvest, one square meter was taken randomly from the middle area of each plot to determine plant height (cm), number of tillers and spikes per m^2, spike length (cm) and thousand kernel weight (g). Grain, straw and biological yields (ton ha^{-1}) were determined from the whole plot area. Harvest index was calculated as the ratio of grain yield to biological yield and was expressed in percent.

Grain crude protein percentage was estimated according the improved Kjeldahl method of AOAC (1990). Data for each trait were analyzed for a split plot in randomized complete block design (RCBD) arrangement according to the procedure outlined by Steel . (1997). Comparisons between means were made using least significant differences (LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

1. Effect of irrigation regime:

1.1. Phonological stages

The results in Table (1) indicated that the different water regime had a pronounced effect on phonological stages in both seasons. The shortest vegetative and reproductive periods were observed when plants were skipped the third irrigation (I_3) followed by I_2 treatment (skipping the second irrigation) in both seasons. However, no significant differences between control treatment (I_1), I_4 (skipping 4th irrigation) and I_5 (skipping 5th irrigation) in both seasons. The results indicate that the wheat plants which skipped from the third irrigation (at elongation and before booting stages) go to early flowering by 5 days compared with control treatment and other irrigation treatments. Also, the same treatment (I_3) caused early maturity than other irrigation treatments. This may be due to the drought stress was occur in end of elongation stage and initiation of booting stage and the plant go to early flowering and early maturation. However, the omitting irrigation at tillering stage or at heading or at ripping stages had no clear effect on days to flowering or maturity. These results are in agreement with those reported by Saleem . (2007) and Mohamed (2013) who reported that increasing drought stress decreased days to heading and days to maturity.

Table 1. Effect of irrigation regime on some phonological stages of wheat

Characters	Season	Irrigation regime*					$LSD_{0.05}$
		I_1	I_2	I_3	I_4	I_5	
Days from sowing to heading	1st	92.73	90.65	87.58	92.28	92.56	1.149
	2nd	91.33	88.2	86.78	91.08	91.36	0.902
Days from sowing to maturity	1st	167.9	159.5	158.7	167.1	166.9	1.133
	2nd	165.8	158.1	157.1	163.6	164.1	1.209
Days from heading to maturity	1st	75.1	68.8	71.9	69.8	68.6	0.872
	2nd	74.4	69.9	70.4	72.6	72.8	1.248

* (I_1: Full irrigation 5 irrigation, I_2: skipping 2nd irrigation, I_3: skipping 3rd irrigation, I_4: skipping 4th irrigation and I_5: skipping 5th irrigation)

1.2. Yield and yield attributes

Irrigation treatments showed s significant effect on grain yield and its components of wheat in both seasons (Table 2). The results indicated that plant height was significantly decreased by skipping one irrigation at various growth stages by 8.86 , 9.79, 3.09 and 0.28% in the first seasons and by 2.89 , 3.71, 1.94 and 0.19 % in the second season, respectively compared with normal irrigation (I_1:control treatment. The great reduction in plant height was noticed at I_2 and I_3 irrigation treatments. However, skipping irrigation at heading and maturity stages had no significantly effect on plant height. These results are agreement with those obtained by Kandile . (2001), El-Sayed (2003), Kassab . (2004), Mohamed (2013) and Aslam . (2014).

The results in regards to number tillers $m^2$of wheat as affected by different irrigation regime are shown in Table 2. The data revealed that skipping irrigation at all growth stages compared with full irrigation treatment in both seasons. The highly reduction in number of tillers m^2 was associated with skipping the second and the third irrigation by 18.78 and 14.13 %,respectively in the first season and by 20.39 and 19.16 %, respectively, in the second season. However, skipping the fourth and fifth irrigation had low reduction in number of tillers m^{-2} compared with other irrigation treatments in both seasons. These results are in line with those found by Mohamed (2013), Zarein . (2014) and Aslam . (2014).

Table 2. Effect of irrigation regime on grain yield and its components of wheat in 2011/2012 and 2012/2013 seasons

Characters	Season	Irrigation regime*					$LSD_{0.05}$
		I_1	I_2	I_3	I_4	I_5	
Plant height (cm)	1st	103.5	94.32	93.36	100.3	103.2	0.972
	2nd	100.5	97.60	96.77	98.55	100.3	0.747
Number of tillers m^{-2}	1st	382.1	310.4	328.1	355.2	370.1	2.581
	2nd	386.8	307.9	312.7	357.5	378.0	2.395
Number of spikes m^{-2}	1st	360.7	292.5	294.9	332.9	348.5	1.728
	2nd	371.3	288.1	285.5	333.1	349.1	2.424
Spike length (cm)	1st	12.02	11.53	11.27	10.67	11.71	0.119
	2nd	11.96	11.50	11.19	10.62	11.78	0.017
1000 –kernel weight (g)	1st	50.19	45.27	43.01	40.29	38.54	0.771
	2nd	43.55	42.47	40.71	39.09	36.44	0.837
Grain yield (ton ha^{-1})	1st	6.927	6.467	6.213	4.855	5.579	0.133
	2nd	6.651	6.397	6.243	4.985	5.467	0.145
Straw yield (ton ha^{-1})	1st	12.03	11.12	11.07	11.67	11.81	0.133
	2nd	11.58	10.56	10.91	11.41	11.58	0.174
Biological yield(ton ha^{-1})	1st	18.96	17.59	17.28	16.52	16.39	0.048
	2nd	18.23	16.96	17.15	16.40	17.05	0.211
Harvest index (%)	1st	36.42	36.57	35.78	29.15	27.80	0.736
	2nd	36.40	37.64	36.28	30.32	32.11	0.732

* (I_1: Full irrigation 5 irrigation, I_2: skipping 2nd irrigation, I_3: skipping 3rd irrigation, I_4: skipping 4th irrigation and I_5: skipping 5th irrigation)

Results indicated that irrigation treatments were significantly different in their effect on number of spikes m^{-2} in both seasons (Table2). Application of five irrigations at different wheat growth stages resulted in higher number of spikes m^{-2} (360.7 and 371.3) in both seasons, respectively. While, skipping the second, third or fourth fifth irrigations caused a reduction in number of spikes m^{-2} by 18.90, 18.24, 7.71 and 3.38%, respectively in the first season and by 22.41, 23.11, 10.29 and 5.98%, respectively in the second season. These results are in accordance with findings observed by Kandil . (2001), Saleem . (2007) and Mohamed (2013).

The results pertaining to spike length of wheat as affected by skipping irrigation are given in Table (2). Omitting irrigation at various growth stages caused significantly reduction in spike length compared with full irrigation in both seasons. The shortest spike length (10.67 and 10.62 cm) was obtained when the wheat plants omitted the fourth irrigation (at heading stage) compared with normal irrigation in both seasons. Similar results were observed by Kandil . (2001), Mohamed (2013).

Regarding 1000-kernel weight (seed index) of weight as influenced by various irrigation scheduling are presented in Table (2).The analysis of variance indicated significant effect on the 1000-kernel weight of wheat. It can be observed from the result the highest 1000-kernel weight (50.19 and 43.55 g) was recorded at normal irrigation (I_1) in both seasons, respectively. However, skipping irrigation at various growth stages decreased 1000-kernel weight in both seasons. The greatest reduction in 1000-kernel weight (23.21 and 19.72%) was noticed when wheat plant exposure to skipping the fourth (I_4) and fifth (I_5) irrigation in the first season and (10.24 and 16.33%) in the second season at the irrigation treatment. These results are in accordance with those obtained by Kandil . (2001), Saleem . (2007) and Mohamed (2013).

Table (2) presents the mean values of grain, straw and biological yields as affected by irrigation regime in 2011/2012 and 2012/2013 seasons. It is clear that significant differences were found among the five irrigation treatments in grain, straw and biological yields in both seasons. The highest grain yield (6.927 and 6.651 ton ha^{-1}) was obtained at full irrigation (I_1 treatment) in both seasons. However, skipping irrigation at various growth stages decreased grain yield ha^{-1} compared with full irrigation. The greatest reduction in grain yield ha^{-1} (29.91 and 27.00 %) was observed at I_4 treatment (skipping the fourth irrigation) followed by (19.46 and 17.80%) at I_5 (skipping the fifth irrigation) compared with full irrigation (I_1) in both seasons, respectively. Also, skipping the second irrigation (I_2) or the third irrigation (I_3) gave a reduction in grain yield ha^{-1} (6.64, 3.81, 10.30 and 6.13%), respectively, in both seasons compared with normal irrigation treatment (I_1). It could be concluded from the previous results that the drastically decreasing in grain yield (ton ha^{-1}) was related to the highly effect of prevent irrigation (drought stress) in both heading (I_4) and ripening (I_5) stages, while, this effect (drought stress) was moderate at vegetative growth stages (I_2 and I_3). The reduction in grain yield (ton ha^{-1}) at I_4 and I_5 treatments was related by reduction in spike length and 1000-kernel weight, however, the reason of decreasing grain yield (ton ha^{-1}) at I_2 and I_3 treatments may be due to reduction in number of tillers m^{-2} and number of spikes m^{-2}.

Mean values of straw yield (ton ha^{-1}) as affected by irrigation regime are presented in Table (2) in both seasons. Straw yield (ton ha^{-1}) was significantly decreased by skipping irrigation at various growth stages in both seasons. The great reduction in straw yield was happened when the wheat plants exposed to skipping the second irrigation (7.56 and 8.80%) followed by skipping the third irrigation (7.98 and 5.79%) in both seasons, respectively. However, the skipping irrigation at both heading (I_4) and maturity (I_5) stages had lower effect on straw yield.

The data of Table (2) showed that significant differences between irrigation treatments in biological yield (ton ha^{-1}) in both seasons. Skipping irrigation at various growth stages had significant reduction in biological yield (ton ha^{-1}) compared with full irrigation in both seasons. Omitting the wheat plants from the fourth irrigation (I_4) led to the greatest reduction (12.86 and 10.04%) in biological yield in both seasons, respectively. Also, skipping the fifth irrigation (I_5) caused decreasing in biological yield by (13.55 and 6.47%), respectively, in both seasons. The reduction in biological yield was related by reduction in grain yield and straw yield. Similar findings were reported by Kandil . (2001), El-Sayed (2003), Kassab . (2004), Saleem . (2007), Banker . (2008), Bayoumi . (2008), Sarwar . (2010), Seleiman . (2011), Abro (2012), Mohamed (2013), Zarein . (2014) and Aslam . (2014).

The harvest index is the percentage of grain from the biological yield produced from a unit area. The data regarding harvest index of wheat as affected by irrigation regime in both seasons are shown in (Table 2). Skipping irrigation at various growth stages exhibited significant effect on harvest index (%) in both seasons. It is evident from the results that skipping the fourth irrigation (I_4) or the fifth irrigation (I_5) gave the lowest values of harvest index (29.15, 30.32, 27.80 and 32.11%) in both seasons, respectively. These results may be related with the results of grain, straw and biological yield. These results coincide with those explained by Seleiman . (2011).

Due to protein content, the data revealed to significant differences between irrigation regime treatments were recorded in both seasons (Fig.1). Skipping irrigation at various growth stages markedly increased protein (%) compared to normal irrigation in both seasons. Also, skipping irrigation caused increasing protein content by (2.70%, 1.77%), (5.41 %, 5.31%), (8.11%, 7.96%) and (10.81% , 9.73%) when wheat plants omitting from the second , third , fourth and fifth irrigation in both seasons, respectively. These results are in harmony with those obtained by Seleiman . (2011) and Mohamed (2013).

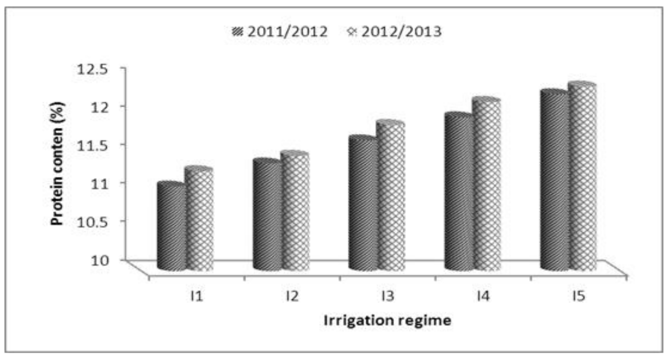

Figure 1. Effect of irrigation regime treatments on protein (%) in grain wheat in 2011/2012 and 2012/2013 seasons.
* (I_1: Full irrigation, I_2: skipping 2nd irrig., I_3: skipping 3rd irrig., I_4: skipping 4th irrig. and I_5: skipping 5th irrig.).

2. Effect of wheat cultivars:

2.1. Phonological stages

Data in Table (3) showed that significantly differences among five wheat cultivars in their phonological stages in 2011/2012 and 2012/2013 seasons. The results revealed to Misr 1 cultivar was earlier in flowering than other wheat cultivars followed by Sids 12 cultivars in both seasons. However, the cultivar Sakha 93 was late in heading date. Regardless days from sowing to maturity, Sids 12 cultivar was earlier in maturity compared with other cultivars. Data in Table (3) indicate to the wheat cultivars were significantly differed in days from heading to maturity. Misr 1 cultivar has the longest flowering and maturity duration (72.5 and 74.9 days) followed by Gemmeiza 9 cultivar in both seasons, respectively. However, Sids 12 gave the shortest flowering and maturity duration (69.9 and 71.05 days) in both seasons, respectively. Comparable results were detected by Mohamed (2013).

Table 3. Effect of some wheat cultivars on some phonological stages in 2011/2012 and 2012/2013 seasons

Characters	Season	Wheat cultivars*					$LSD_{0.05}$
		Sids 12	Gemmeiza 9	Sakha 93	Misr 1	Misr3	
Days from sowing to heading	1st	91.01	91.79	91.28	90.30	91.42	0.60
	2nd	88.75	90.29	91.28	87.63	90.80	0.57
Days from sowing to maturity	1st	160.9	162.8	161.5	162.8	162.0	1.78
	2nd	159.8	162.2	161.9	162.5	162.4	1.22
Days from heading to maturity	1st	69.9	71.0	70.2	72.5	70.5	1.86
	2nd	71.05	71.9	70.62	74.9	71.6	3.13

2.2. Yield and yield attributes:

Data in Table (4) showed that the effect of five wheat cultivars on yield and its components in 2011/2012 and 2012/2013 seasons. The plant height of wheat was markedly higher (120.0 and 112.5 cm) in Sids 12 cultivar in both seasons, respectively.

While, cultivar Gemmeiza 9 was ranked in the second order with average plant height of 99.78 and 99.31 cm in both seasons, respectively. However, the shortest plant height of 91.27 and 94.55 cm was recorded in Misr 3 cultivar.

Table 4. Effect of five wheat cultivars on grain yield and its components in 2011/2012 and 2012/2013 seasons

Characters	Season	Wheat cultivars					$LSD_{0.05}$
		Sids 12	Gemmeiza 9	Sakha 93	Misr 1	Misr 3	
Plant height (cm)	1st	120.0	99.78	92.14	91.55	91.27	0.82
	2nd	112.5	99.31	94.16	94.23	94.55	0.92
Number of tillers m^{-2}	1st	376.5	311.8	350.5	350.7	356.4	3.82
	2nd	357.9	334.8	349.9	347.0	353.4	2.52
Number of spikes m^{-2}	1st	350.9	279.7	331.4	333.4	334.1	2.25
	2nd	336.8	294.1	330.7	329.3	336.3	2.31
Spike length (cm)	1st	12.96	12.33	10.94	10.26	10.71	0.27
	2nd	12.82	12.08	11.00	10.59	10.56	0.14
1000-kernel weight (g)	1st	46.57	45.16	43.66	41.05	40.88	0.94
	2nd	42.08	41.33	40.91	39.33	38.63	0.46
Grain yield (ton ha^{-1})	1st	6.797	5.960	4.262	5.965	6.057	0.11
	2nd	6.747	5.880	5.116	6.018	5.981	0.34
Straw yield (ton ha^{-1})	1st	12.72	11.51	11.02	11.39	11.07	0.20
	2nd	12.13	11.19	10.83	11.07	10.81	0.19
Biological yield (ton ha^{-1})	1st	19.51	17.47	15.28	17.35	17.12	0.27
	2nd	18.88	17.08	15.94	17.09	16.79	0.27
Harvest index (%)	1st	34.70	34.02	27.22	34.13	35.15	0.43
	2nd	35.72	34.44	32.03	35.07	35.48	0.62

The results indicated that the differences in number of tillers m^{-2} of wheat were significant due to different cultivars in both seasons (Table 4). Sids 12 cultivar resulted in significantly maximum number of tillers m^{-2} (376.5 and 357.9) in both seasons, respectively, followed by Misr 1 cultivar (356.4 and 353.4), followed by Misr 3 cultivar (350.7 and 347.0) in both seasons, respectively. However, Gemmeiza 9 cultivar gave the lowest tillers number m^{-2} (311.8 and 334.8) in both seasons, respectively. The results pertaining to number of spikes m^{-2} as affected by wheat cultivars are given in Table (4) in 2011/2012 and 2012/2013 seasons. The highest number of spikes m^{-2} was recorded in Sids 12 cultivars (350.9 and 336.8) in both seasons, respectively. While, Gemmeiza 9 gave the lowest number of spikes m^{-2} (279.7 and 294.1) in both seasons, respectively. From the previous results it should be noted that there is a relationship between the number of tillers per square meter and the number of spikes per square meter in the same cultivar.

The results in relation to spike length as influenced by wheat cultivars are shown in Table (4) in 2011/2012 and 2012/2013 seasons. The obtained data showed that significant differences between wheat cultivars in spike length in both seasons. Sids 12 cultivar had longest spikes (12.96 and 12.82 cm) in both seasons followed by Gemmeiza 9 (12.33 and 12.08 cm) in both seasons. However, Misr 1 cultivar gave the lowest values of spike length (10.26 and 10.59 cm) followed by Misr 3 (10.71 and 10.56 cm) in both seasons, respectively.

Regarding to 1000-kernel weight of wheat cultivars the data are given in Table (4). The differences between wheat cultivars in 1000-kernel weight were significant in 2011/2012 and 2012/2013 seasons. Sids 12 gave the heaviest1000-kernel weight (46.57 and 42.08 g) followed by Gemmeiza 9 cultivar (45.16 and 41.33 g) followed by Sakha 93 cultivar (43.66 and 40.91 g) in both seasons, respectively. While, both Misr1 and Misr 3 cultivars gave the lowest values of 1000-kernel weight (11.39 and 11.07 g) and (11.07 and 10.81 g) in both seasons, respectively.

The data in Table (4) showed that significant difference among wheat cultivars in grain yield (ton ha^{-1}) in 2011/2012 and 2012/2013 seasons. The results indicated that Sids 12 cultivar was surpassed other wheat cultivars in grain yield (ton ha^{-1}). Sids 12 cultivar gave the greatest grain yield (6.797 and 6.747 ton ha^{-1}) followed by Misr 3 cultivar (6.057 and 5.981 ton ha^{-1}) followed by Misr 1 cultivar (5.965 and 6.018 ton ha^{-1}) in both seasons, respectively. However, the lowest grain yield (4.262 and 5.116 to ha^{-1}) was recorded in Sakha 93 cultivar in both seasons, respectively.

Results in table (4) indicated that wheat cultivars were differed in its straw yield (ton ha^{-1}) in both seasons. Maximum value of straw yield was produced with Sids 12 cultivar (12.72 and 12.13 ton ha^{-1}), while minimum value of straw yield was observed in Sakha 93 cultivar (11.02 and 10.83 ton ha^{-1}) in both seasons, respectively.

Biological yield of wheat is the total biomass weight of the plant including straw and grains. The results of biological yield (ton ha^{-1}) as influenced by various wheat cultivars are presented in Table (4) in bot seasons. The data indicated that the difference among wheat cultivars were significant in both seasons. Clearly, the cultivar Sids 12 gave the highest biological yield (19.51 and 18.88 ton ha^{-1}) followed by Gemmaiza 9 (17.47 and 17.08 ton ha^{-1}) followed by Misr 1(17.35 and 17.09 ton ha^{-1}) and Misr 3 (17.12 and 16.79 ton ha^{-1}) in both seasons, respectively. However, the lowest value of biological yield (15.28 and 15.94 ton ha^{-1}) was recorded in Sakha 93 cultivar in both seasons, respectively. Results presented in Table (4) show that, harvest index was significantly affected by five wheat cultivars in 2011/202 and 2012/2013 seasons. It was evident that wheat cultivar Misr 1 gave the highest value of harvest index (35.15%) in the first season, while Sids 12 cultivar gave the maximum value of harvest index

(35.72%) in the second season. On the other hand, Sakha 93 cultivar was produced the lowest value of harvest index (27.22 and 32.03 %) in both seasons. The previous results are in agreement with those obtained by Kandil . (2001), Saleem . (2007), Bayoumi . (2008), Sarwar . (2010), Mohamed (2013), Zarein . (2014) and Aslam . (2014).

2.3.Protein content (%):

Fig. (2) illustrated that the effect of five wheat cultivars on protein content (%) in 2011/2012 and 2012/2013 seasons. The results indicated that significant difference between wheat cultivars were recorded in protein content (%) in both seasons. Sids 12 cultivar surpassed in protein content (12.69 and 12.19%) the other wheat cultivars in both seasons. However, Gemmeiza 9 cultivar gave the lowest value of protein content (10.42 and 10.57) in both seasons, respectively. These results are in close agreement with those of Mohamed (2013).

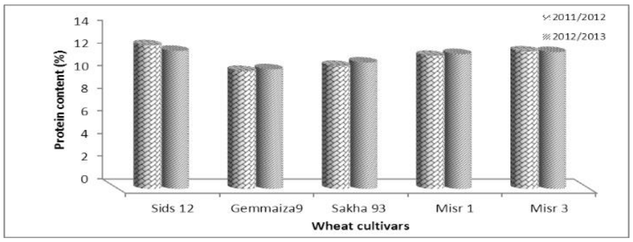

Figure 2. Effect of wheat cultivars on grain protein content (%) in 2011/2012 and 2012/2013 seasons

3. Interaction Effect:

The results in regards to grain yield (ton ha^{-1}) of five wheat cultivars as affect by different irrigation regime in 2011/2012 and 2012/2013 seasons are shown in Fig.3 and 4. The effect of interaction between wheat cultivars and irrigation regime were significant in both seasons. Moreover, grain yield of all five wheat cultivars were affected by skipping irrigation at various growth stages in both seasons. Skipping irrigation at various growth stages had a reduction in grain yield (ton ha^{-1}) in all wheat cultivars in both seasons. In explicit, these results evidenced that Sakha 9 cultivar was more affected by skipping irrigation than other cultivars in both seasons (Figs. 3 and 4). Sids 12, Misr 1 and Misr 3 cultivars were clearly affected by skipping irrigation at various growth stages compared with other cultivars. Skipping the fourth or fifth irrigation caused high reduction in grain yield (ton ha^{-1}) in both seasons. In addition, skipping the second or third irrigation was recorded low reduction.

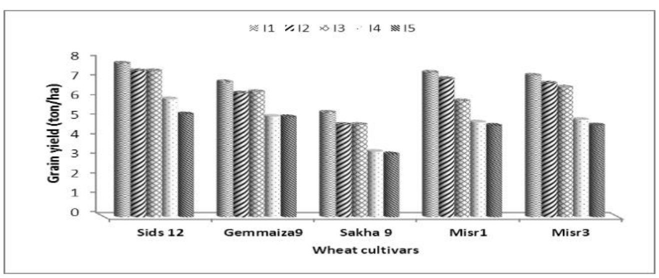

Figure 3. Effect of interaction between wheat cultivars and irrigation regime in 2011/2012 season

* (I_1: Full irrigation, I_2: skipping 2nd irrig., I_3: skipping 3rd irrig., I_4: skipping 4th irrig. and I_5: skipping 5th irrig.)

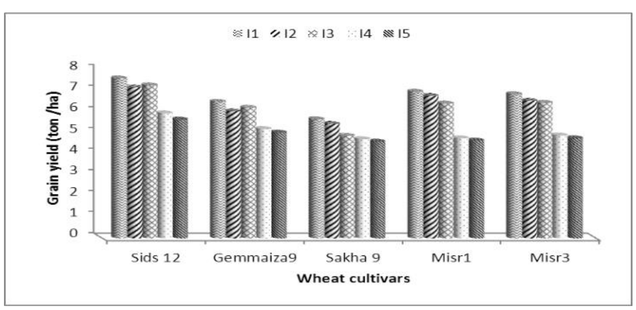

Figure 4. Effect of interaction between wheat cultivars and irrigation regime in 2012/2013 season

* (I_1: Full irrigation, I_2: skipping 2nd irrig., I_3: skipping 3rd irrig., I_4: skipping 4th irrig. and I_5: skipping 5th irrig.).

CONCLUSION

It could be concluded that skipping irrigation at various growth stages significantly decreased days to heading, days to maturity, plant height, number of tillers m^{-2}, number of spikes m^{-2}, spike length, 1000-kernel weight, grain, straw, biological yields and harvest index compared with normal irrigation. It is obviously, that skipped the fourth or the fifth irrigation led to high reduction in all yield traits, except protein content was increased. Significant differences between wheat cultivars were recorded in phonological stages, yield and its components and protein content. Sids 12 cultivar was more tolerant to skipping irrigation at various growth stages compared with other studied wheat cultivars

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