J. Plant Production, Mansoura Univ., Vol. 6 (6): 943 - 963, 2015

RESPONSE OF 21 SPRING BREAD WHEAT GENOTYPES TO NORMAL AND REDUCED IRRIGATION IN NORTH DELTA

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ABSTRACT

This study was conducted to evaluate 21 bread wheat genotypes includes 13 Egyptian cultivars under normal (five irrigations) and reduced irrigation (only the establishment irrigation) during 2010/11 and 2011/12 wheat growing seasons. The studied characters were: number of days to heading and maturity, grain filling period and rate, plant height, number of spikes m^{-2}, number of kernels per spike, kernel weight, grain yield, biological yield, straw yield, harvest index and stress susceptibility index. The variances due to genotypes were significant for all characters under all conditions and were higher under normal irrigation compared with those resulted from reduced irrigation for most characters across the two seasons, reflecting sufficient genetic variability between these entries, better expression of genetic potential and the importance of selection based on nonstress environment. Significant variations were detected due to water regimes, genotypes and interactions between genotypes and water regimes for most characters. The mean squares of irrigation regimes explained most of the total variations for most characters in the two seasons, indicating the relative importance of irrigation treatments in breeding programs for water stress tolerance. The variances due to genotypes were higher than those of interactions between genotypes and water regimes for most characters. The means of all genotypes significantly decreased for most characters in the two seasons under reduced irrigation. Number of spikes m^{-2} and harvest index were the most and least affected characters by reduced irrigation in the two seasons, respectively. Line 1, Line 2 and Line 3 were the earliest genotypes for days to heading and maturity and could be used as a source of earliness in breeding program. There were manifested declines in the temperature during the second season than the first one, resulting in lower mean squares of genotypes and higher means of all genotypes in the second season in most cases. The average reduction for all characters tended to increase under the second season for most characters. Regardless the yield potentiality, Cham 4 then Sakha 93 were the most tolerant genotypes to water stress in the two seasons and could be used as source of water stress tolerance in breeding programs, while Gemmeiza 9 was vice versa. Sakha 94 had high yield potential and water stress tolerance and hence recommended to be used as parent for genetic analysis and improvement of water stress tolerance in wheat breeding programs. Misr 1, Misr 2, Sids 13 and Shandweel 1 showed the high yield potentiality and susceptibility to water stress and could be used as source for yield potential improvement only. Sids 12 in the two seasons showed low yield potential and susceptibility to water stress. The remaining genotypes had year-to-year variation in grain yield potentiality and stress susceptibility index. Generally, some water stress tolerant-genotypes under this study are not necessarily to be the highest in yield potentiality.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important crops in Egypt. It has long been recognized that wheat productivity vary considerably as a result of genotype, environment and their interaction. Moreover, one of the most constraints for agriculture in Egypt is irrigation water limitation.

There are several direct and indirect ways in which water stress can be induced in field, greenhouse, pots, growth chamber or in laboratory. In field experiments, using surface irrigation, water stress could be induced by withholding irrigations at different stages or increasing of irrigation intervals in rain-free environment.

Variation for adaptation to water stress among genotypes has been reported in wheat (Farooq et al., 2014). As most of the Egyptian wheat is produced under irrigated conditions, it is essential to determine the response of wheat genotypes to water regimes. According to many previous studies, reduction in the cycle length of the plant life (Bayoumi et al., 2008; and Hamam, 2008) and grain filling periods and rates (Madani et al., 2010) are some of the primary effects of the water deficit. Imposition of water stress caused a greater reduction in plant height (Mahamed et al., 2011), biological, straw and grain yield and its components and harvest index (Waraich and Ahmad, 2010; Mahamed et al., 2011; and Saeidi and Abdoli, 2015). On the other hand, in some studies, some agronomic characters did not affected under reduced irrigation such as number of kernels per spike (Tahmasebi et al., 2007) and kernel weight (Okuyama et al. , 2004).

Yield trials to evaluate elite lines in a wide range of environments are important in plant breeding. These genotypes could be used in breeding programs according to three strategies i.e., evaluation under optimal or stress prone environments or making the superior genotypes under normal environments better adapted to stress conditions by incorporation of relevant stress tolerant attributes into these genotypes (Blum, 1979; and Rajaram and vanGinkel, 2001).

Several selection criteria are proposed to select genotypes based on their performance in stress and nonstress environments. A stress susceptibility index (SSI) provides a measure of stress tolerance based on minimization of yield loss under stress as compared with optimum conditions (Fisher and Maurer, 1978). There are many reports in literature on the use of SSI for identifying wheat genotypes with yield stability in moisture limited environments (Farhat 2009). According to Fernandez (1992), the best measure for selection in water stress condition could be able to separate genotypes which have desirable and similar yield in stress and non-stress conditions from other groups. Three-dimensional plots using grain yield under normal and reduced irrigation and selection criterion were used to show the interrelationships among these three variables and separate genotypes of desirable and similar yield in stress and non-stress conditions from other ones.

Therefore, the objective of this study was to a) evaluate some Egyptian bread wheat cultivars and genotypes under normal and reduced irrigation, b) characterize the relative tolerance to water stress in Egyptian cultivars and c) determine relative contributions of genotype, reduced irrigation and their interaction to the variation in the studied characters tested across two seasons.

MATERIALS AND METHODS

This study was conducted at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt (31° 5' 12" North, 30° 56' 49" East). Twenty-one bread wheat (*Triticum aestivum* L.) genotypes were used and grown on 28th, November during 2010/11 and 2011/12 wheat growing seasons. The name and pedigree of the studied genotypes are listed in Table 1.

Table 1: Name and pedigree of the studied wheat genotypes.

Genotype	Pedigree/Cross Name
1-Giza 168	MIL/BUC//SERI
2-Sakha 93	SAKHA 92/TR 810328
3-Sakha 94	OPATA/RAYON//KAUZ
4-Misr 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR
5-Misr 2	SKAUZ/BAV92
6-Gemmeiza7	CMH 74A.630 / 5X // SERI 82 /3/ AGENT
7-Gemmeiza9	ALD"S"/HUAC"S"//CMH74A.630/5X
8-Gemmeiza10	MAYA74"S"/ON//II60.147/3/BB/GLL/4/CHAT"S"/5/CROW"S"
9-Gemmeiza11	BOW"S"/KVZ"S"//7C/SER182/3 /GIZA168/SAKHA 61
10-Sids 1	HD2172/PAVON"S"//1158.57/MAYA74"S"
11-Sids 12	BUC//7C/ALD/5/MAYA74/ON//II60.147/3/BB/GLL/4/CHAT"S"/6/MAYA/VUL//CMH74A.630/4*SX
12-Sids 13	KAUZ"S"//TSI/SNB"S"
13-Shandweel1	SITE//MO/4/NAC/TH.AC//3*PVN/3/MIRLO/BUC.
14-Line 1	GIZA 158 /5/ CFN /CNO "S" // RON /3/ BB / NOR 67 /4/ TL /3/ FN / TH // NAR 59*2
15-Line 2	GIZA 164 / SAKHA 61
16-Line 3	SAKHA 8 / YECORA ROJO
17-Line 4	VOROBEY
18-Cham 4	FLK/HORK
19-Cham 6	W391A/JUPATECO 73
20-Cham 8	JUPATICO 73/BLUE JAY//URES 81
21-Cham 10	KAUZ//KAUZ/STAR

In each season, the studied entries were evaluated in two separate irrigation regime experiments using flood irrigation method. The first regime included the establishment and four irrigations (Normal, N), while the second one included only the establishment irrigation (reduced irrigation, S).The establishment irrigation was about 500 m^3 fed^{-1} in each experiment in the two seasons, while the remaining four irrigations were about 1310 m^3 $fed^{-1}$and 1390 m^3 fed^{-1} in the normal experiments in the first and second season, respectively. In addition, the rainfall were equal to 654.9 m^3 fed^{-1} and 514.9 m^3 fed^{-1} in the first and second seasons, respectively (Table 2). Each experiment was surrounded by a wide border (5m) to minimize the underground water permeability. The experimental site was close to main drainage canal, indicating the remoteness of the soil water level. Except for irrigation, recommended cultural practices for wheat cultivation in old land in Egypt were applied at the proper time. The preceding crop was maize in the two seasons. Readings of water table levels were taken at intervals during the irrigation events. According to proceeding of Page (1982) and Klute (1986), the soil texture was a clay with a pH of 8.8 and increased with depths and EC ranged from 0.98 to 2.32 dsm^{-1} over the two seasons. The meteorological data for the two winter growing seasons at Sakha meteorological station are given in Table 2.

Table 2: Monthly mean of air temperature (AT ^{O}C), relative humidity (RH %) and rainfed (mm/month) in winter seasons 2010/2011 and 2011/2012 at Sakha site.

Month	AT ^{O}C 2010/2011		AT ^{O}C 2011/2012		RH%		Rainfed (mm)	
	Max.*	Min.**	Max.	Min.	2010/ 2011	2011/ 2012	2010/ 2011	2011/ 2012
November	26.8	10.9	23.6	10.1	67.6	65.8	-	-
December	22.6	8.5	20.4	6.4	72.5	60.0	90.0	14.6
January	21.0	5.7	10.1	8.6	71.3	63.1	18.3	32.5
February	21.6	7.0	11.3	9.5	65.7	70.7	22.9	32.7
March	22.5	6.7	14.1	12.1	70.1	91.5	13.6	42.8
April	26.4	9.9	19.0	17.0	66.1	89.7	11.1	-
May	30.1	13.3	22.6	20.8	59.2	100.1	-	-

*** Max = maximum temperature, ** Min = minimum temperature.**

A randomized complete block design with six replications was used for each water regime. The plot area was 1.5 m^2 and consisted of two rows, 2 m long and 30 cm apart. Grains were manually drilled in the rows at the rate of 300 seeds m^{-2}.

The studied characters were: number of days to heading (DH) and maturity (DM), grain filling period (FP, days and equal to the number of days from heading to maturity) and rate (FR, gm m^{-2} $days^{-1}$ and equal to GY divided by FP), plant height (Ph, cm), number of spikes m^{-2} (SM), number of kernels per spike (KS), 1000-kernel weight (KW, gm), Grain yield (GY, kg m^{-2}), Biological yield (BY, kg m^{-2}), Straw yield (SY, kg m^{-2}) and Harvest index (HI, was estimated as the ratio of GY to BY and was expressed in percent).

Stress susceptibility index (SSI) was calculated using a generalized formula (Fisher and Maurer 1978) in which: SSI = (1 - Y_d / Y_p) / D. Where: Y_d = mean yield under reduced irrigation, Y_p = mean yield under normal irrigation = potential yield, D = water stress intensity = 1 - (mean Y_d of all genotypes / mean Y_p of all genotypes). Moreover, three-dimensional plots among grain yield under normal and reduced irrigation and SSI were drew according to Fernandez (1992) using Statistica software ver.10 (2010).

The statistical analyses were performed using the statistical routines available in Microsoft EXCEL (2013). The percentage contribution of each variance component was estimated by summing the appropriate terms to give an estimate of total variance and then dividing the specific variance component by the total variance. Prior to conducting combined analysis, the error variance at each irrigation regime tested through the application of the F test in two tail as described in Gomez and Gomez (1984). The maximum, minimum, ranges and means of irrigation regimes and genotypes were obtained and differences between genotypes' means were assessed with LSD at 5% level of probability. Seasons were random, while the irrigation treatments and genotypes were fixed.

RESULTS

The water table levels in the two seasons reached deeper than 180 cm after 60 days from sowing under the reduced irrigation treatment (at booting stage for most genotypes). While, it reached the same depth after 150 days from sowing under the normal irrigation treatment. As in Table 2, there were manifested declines in the temperature throughout the second season compared with the first one.

1) Analysis of variance:

Mean squares of the studied characters under the two irrigation regimes across the two seasons are illustrated in Table 3. The genotypes showed significant (0.01 probability) variances for all characters in all conditions. Moreover, the mean squares of genotypes under the normal water regime were higher than those under the reduced one for all characters in the two seasons, except for HI in the two seasons; for DM, FP, SM and KW in season 1; and for BY, SY and KS in the second season. Meanwhile, the mean squares due to genotypes in the first season were higher than those in the second one for the two water regimes for all characters, except for HI.

Homogeneity test showed that the error variances were heterogeneous across the two seasons and homogeneous for the two irrigation regimes in the two seasons for most characters. Therefore, the combined analyses were performed only for the two irrigation regimes in each season for all characters, except for KS and KW in season 1; and for DH and FP in season 2 (Table 4).

The mean squares due to water regimes, genotypes and interactions between genotypes and water regimes were significant (0.05 or 0.01 probability) for all characters, except for DH and FR in season 1 and SY and HI in season 2 for water regimes; and for BY and SM in both seasons, FP and SY in season 1 and FR, Ph and KW in season 2 for interactions between genotypes and water regimes. Moreover, the mean squares due to irrigation regimes were the most important source of the total mean squares followed by genotype mean squares for all characters, except for DH and FR in season 1 and HI in the season 2.

3-

4-

2)-Means performance:

Table 5 shows the average values of the studied characters, as well as the maximum, minimum and ranges of these characters under the two water regimes in the two seasons. The means of all genotypes decreased significantly (Tables 3 and 5) under the reduced irrigation for all characters in the two seasons, except for HI in the two seasons; DH and FR in the first season; and SY in the second season. This was true for the means of most genotypes in the two seasons. Meanwhile, the means of all genotypes increased significantly under the reduced irrigation for HI in the first season.
The maximum and minimum values for the studied characters tended to decrease under reduced irrigation in the two seasons, except for maximum and minimum values of HI and minimum values of FR and GY in the two seasons; and maximum values of SM and minimum values of KS and KW in the first season. The ranges between the maximum and minimum values of all characters deceased under the reduced irrigation, except for FP and HI in the two seasons; SM and KS in season 1; and BY and SY in season 2 (Table 5).

The means of all genotypes in the second season were higher than those in the first season under normal and reduced irrigation for all characters, except for FP under the two water regimes; Ph and SY under normal irrigation; and KW under reduced irrigation. In addition, the maximum and minimum values of all characters increased in the second season, except for maximum and minimum values of FP under the two irrigation regimes and KS under reduced irrigation; maximum values for BY, SY and SM under the two water regimes, Ph under normal irrigation and HI under reduced irrigation; and minimum values of GY and HI under normal irrigation. Meanwhile, the ranges between the maximum and minimum values were lower in the second season than the first one for all characters, except for GY and HI under the two water regimes and KS under reduced irrigation.

Line 2 was the earliest genotype for DH and DM under most conditions, while Cham 4 and Gemmeiza 9 were vice versa. The longest FP were reached in Sakha 93, while Sakha 94 and Line 4 had the shortest FP under all conditions. The highest FR were observed in Misr 1 and Misr 2, while Sakha 93 and Cham 4 showed the slowest FR in most conditions. The tallest genotypes were Misr 2, Gemmeiza 7 and Line 1, while the shortest genotypes were Sakha 93, Gemmeiza 10, Line 3 and Sids 13 in most conditions. Gemmeiza 9, Shandweel 1, Misr 1 and Misr 2 had the highest BY under most conditions, while Sakha 93 and Line 3 had the lowest BY under all conditions. The highest GY was obtained from Misr 1, Sids 13, Misr 2, Shandweel 1 and Sids 1 in most conditions, while, the lowest GY belonged to Sakha 93, Cham 4 and Cham 10 in most conditions. SY reached the highest values in Sids 1, Gemmeiza 9, Shandweel 1, Misr 1 and Line 4; and the lowest values in Line 3, Sakha 93 and Cham 10 in most conditions. The highest values of SM were found in Misr 2, Sids 13, Cham 4, Cham 6, Cham 8, Line 3 and Line 4 under most conditions, while the lowest values of SM were obtained in Gemmeiza 7, Gemmeiza 11, Sids 12 and Line 2 under most conditions. Shandweel 1, Sids 12, Sids 13, Line 1 and Cham 8 showed the highest KS under most conditions, while Sakha 93, Line 2 and Line 3 were vice versa in most conditions. The highest KW resulted from Line 1, Line 2, Line 3 and Gemmeiza 11 in most conditions, while the lowest values of KW belonged to Cham 4, Cham 6, Cham 8 and Cham 10 in most conditions. Only under the reduced irrigation, the highest values were observed for BY in Sids 1; for GY in Sakha 94; and for KS in Sids 12 and Gemmeiza 11, while the lowest values were observed for Ph in Sids 12 and Cham 4; and for SY in Giza 168.

The average reduction due to reduced irrigation ranged from -4.44% for HI to 12.21% for SM in the first season and from 0.27 for HI to 10.11 for SM in the second season (Table 6). SM in the two seasons along with SY and BY in first season and GY and KW in second season were the characters most affected by reduced irrigation. In addition, reduced irrigation resulted in an increase in HI in the first season. Moreover, HI, DH, DM and FR in the first season were the least affected characters by reduced irrigation. Also, the average reduction for all characters tended to increase under the second season, except for Ph, BY and SY.

The range of the reduction due to reduced irrigation extended from 3.27 % for DH to 41.10 for GY in the first season and from 3.65 for DM to 58.94 % for HI in the second season (Table 6). The highest ranges of reduction were observed for GY and FR in the first season and for HI and SY in the second season. On the other hand, DM and DH in the two seasons had the least ranges of reduction. Moreover, the ranges of reduction were higher in the second season compared with the first one for DH, DM, BY, SY, HI and KW, whereas the remaining characters were vice versa.

Table 6: Means and ranges of reduction due to reduced irrigation for the studied characters of the 21 wheat genotypes in seasons 2010/11 and 2011/2012.

Characters	Reduction percentage			
	Mean		Range	
	2010/2011	2011/2012	2010/2011	2011/2012
Days to heading	0.734	4.743	3.269	7.477
Days to maturity	1.571	4.631	3.528	3.654
Grain filling period	3.227	4.328	9.555	9.325
Grain filling rate	1.106	5.149	38.951	25.739
Plant height	6.216	4.440	12.636	8.594
Biological Yield	8.416	7.767	19.036	20.870
Grain yield	4.206	9.178	41.103	30.030
Straw yield	11.319	5.589	21.500	55.154
Harvest index	-4.438	0.272	28.805	58.938
No. of spikes m^{-2}	12.213	10.109	33.405	18.191
No. of kernel per spike	3.014	4.859	19.544	13.370
1000-kernel weight	0.780	8.743	12.386	15.476

3)Stress susceptibility index (SSI):

Table 7 illustrate stress susceptibility index (SSI) based on grain yield for the studied genotypes in the two seasons. Cham 4 then Sakha 93 revealed the lowest SSI, while the highest SSI belonged to Gemmeiza 9 in the two seasons. It could be considered that genotypes with SSI values less than 1 are tolerant to water stress; higher than 1 are sensitive to water stress; and equal or near to 1 are moderate tolerant or sensitive to water stress. In the two seasons, Sakha 93, Sakha 94, Line 2, Line 3, Cham 4 and Cham 6 were tolerant; Gemmeiza 11 was moderately tolerant, and Giza 168, Misr 2, Gemmeiza 9, Sids 13 and Cham 8 were sensitive to water stress. Sids 1 and Line 4 ranged from moderately tolerant; Misr 1, Gemmeiza 7, Gemmeiza 10, Sids 12 and Line 1 ranged from sensitive to moderately tolerant; and Shandweel 1 and Cham 10 ranged from sensitive to tolerant to water stress in the two seasons.

Three-dimensional plots among grain yield under normal (x-axis) and reduced (y-axis) irrigation along with stress susceptibility index (z-axis) in the two seasons are presented in Fig. 1. The X-Y plane is divided into four segments by drawing intersecting lines through grain yield under normal and reduced irrigations and the four groups are marked as group A to group D. Group A included Sakha 94, Misr 1, Misr 2, Sids 13 and Shandweel 1 in the two seasons; Line 4 in the first season; and Gemmeiza 10, Gemmeiza 11 and Sids 1 in the second season. Meanwhile, group B contained Gemmeiza 9 and Line 1 in the two seasons; Gemmeiza 10 in season 1; and Giza 168, Gemmeiza 7, Line 4, Cham 8 and Cham 10 in the second season. In addition, group C comprised Sids 1 and Cham 4 in the first season, but did not have any genotypes in the second season. Moreover, group D had Sakha 93, Sids 12, Line 2, Line 3 and Cham 6 in the two seasons; Giza 168, Gemmeiza 7, Gemmeiza 11, Cham 8 and Cham 10 in the first season; and Chm 4 in the second season. The high yield potentiality under the two water regimes went with the high water stress tolerance in Sakha 94 in the two seasons; Line 4 in the first season; and Gemmeiza 11 and Sids 1 in the second season. In addition, Misr 1, Misr 2, Sids 13 and Shandweel 1 in the two seasons; and Gemmeiza 10 and Sids 1 in the second season were high yielding and susceptible to water stress.

Table 7: Estimates of stress susceptibility index based on grain yield for the studied genotypes.

Genotypes	2010/2011	2011/2012
Giza 168	2.76	1.41
Sakha 93	-1.99	-0.46
Sakha 94	-1.12	0.85
Misr 1	2.00	1.06
Misr 2	1.59	1.38
Gemmeiza 7	1.22	1.52
Gemmeiza 9	4.84	2.14
Gemmeiza 10	1.42	0.97
Gemmeiza 11	1.27	1.26
Sids 1	-1.64	1.06
Sids 12	1.20	1.34
Sids 13	3.09	1.35
Shandweel 1	1.38	0.06
Line 1	3.20	1.07
Line 2	0.69	0.55
Line 3	-1.51	0.42
Line 4	0.33	1.14
Cham 4	-3.49	-0.95
Cham 6	0.16	0.20
Cham 8	1.97	1.44
Cham 10	0.52	2.01

The high yield potentiality under normal irrigation and water stress susceptibility were observed in Gemmeiza 9 and Line 1 in the two seasons; Gemmeiza 10 in the first season and Giza 168, Gemmeiza 7 and Cham 8 in the second season, while Line 4 in the second season was high yielding under normal irrigation and tolerant to water stress. Meanwhile, the low grain yield potentiality under the two irrigations corresponded with the susceptibility to the water stress in Sids 12 in the two seasons; and Giza 168, Gemmeiza 7 and Cham 8 in the first season. Moreover, Cham 4 and Sids 1 had the highest grain yield under reduced irrigation and were tolerant to water stress in the first season. The lowest grain yield under reduced irrigation and the highest water stress tolerance belonged to Cham 4 in the second season. Shandweel 1 and Cham 10 showed fluctuation response to water stress across the two seasons.

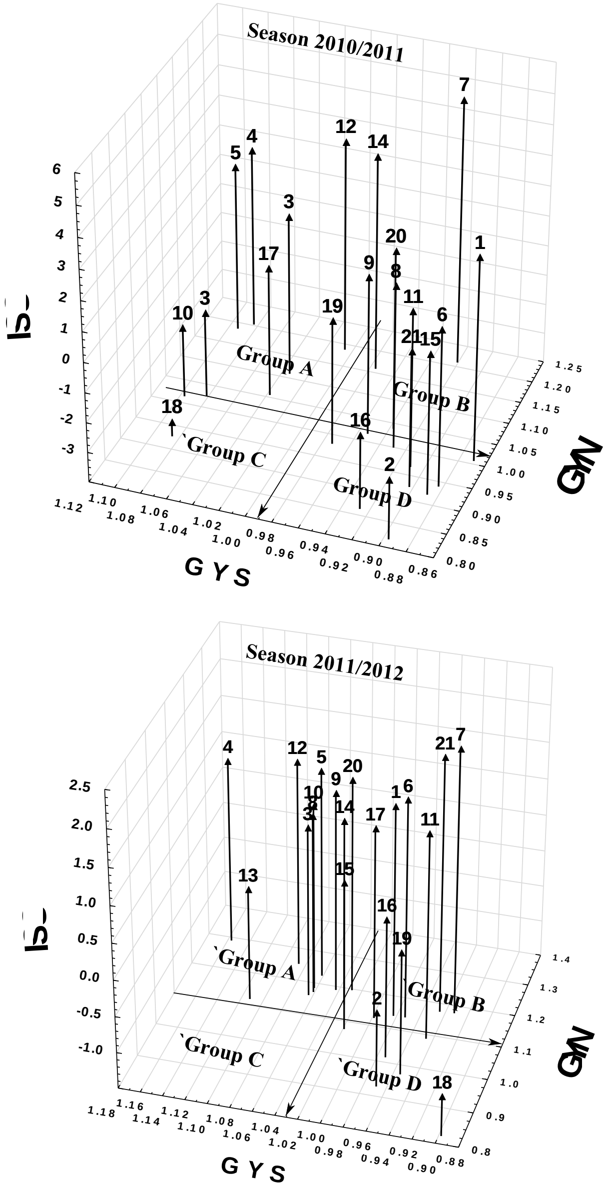

Fig. 1: The 3-dimentional plots among stress susceptibility index (SSI) and grain yield under normal (GYN) and reduced (GYS) irrigation in seasons 2010/2011 and 2011/2012 for the 21 studied genotypes.

1 = Giza 168, 2 = Sakha 93, 3 = Sakha 94, 4 = Misr 1, 5 = Misr 2, 6 = Gemmeiza 7, 7 = Gemmeiza 9, 8 = Gemmeiza 10, 9 = Gemmeiza 11, 10 = Sids 1, 11 = Sids 12, 12 = Sids 13, 13 = Shandweel 1, 14 = Line 1, 15 = Line 2, 16 = Line 3, 17 = Line 4, 18 = Cham 4, 19 = Cham 6, 20 = Cham 8, 21 = Cham 10.

DISCUSSION

The experimental sites were chosen to represent the agricultural environments of production areas in north delta. Rajaram et al. (1996) concluded that simultaneous evaluation of the germplasm both under near optimum condition (to identify genotypes with high yield potential) and stress conditions (to preserve alleles for water stress tolerance) is important to breed for higher yielding and drought tolerant genotypes. Moreover, the experiments were repeated across two seasons to give greater reliability to the results. As in Table 2, the season 2 had considerable lower daily air temperatures rather than the season 1 in all months.

1) Analysis of variance:

The analysis of variance was performed to separate the genetic from the other components of the phenotypic variances then test the significance of these components under the two water regimes in the two seasons. The significance of genotypes' variances for all characters under all conditions reflect the presence of sufficient genetic variability between these entries and provides the basis for genetic gain and the adaptation in any breeding program (Rajaram et al., 1996). Comparing the mean squares of genotypes under the normal and reduced irrigation showed greater genotypic variances under normal irrigation for most characters across the two seasons. The evaluation in the non-stress environment allowed a better expression of genetic potential and the selection based on nonstress environment outperformed the selection from the stress environment (Ahmed *et al*., 2014). A similar trend of results was found by Mohammadi et al. (2011), and Abd El-Mohsen et al. (2015).

Moreover, low temperature in the second season may resulted in lower mean squares of genotypes in the second season compared with the first one in most cases. In this respect, Singh and Byerlee (1990) stated that yield variability tended to be higher in warmer subtropical countries due heat stress. According to Hassanein et al. (2012), plants at Sakha location will be less influenced by the increase in air temperature by 1.5°C and by the increase air temperature with 3.5°C, plants will lose ability to grow at the normal rate which will lead to significant loss in yield.

The analysis of variance was performed over the two water regimes to estimate the effect of water regimes, genotypes and the interactions between water regimes and genotypes then test the significance and compare these components in the two seasons. Significant variations were observed due to water regimes, genotypes and interactions between genotypes and water regimes for most characters. The significance of the interactions is a result of the different abilities of the cultivars to adjust their characters to the environment, suggesting the importance of genotypes assessment under different environments to identify the best ones for a particular environment. Previous studies have indicated that most earliness and yield and yield components characters were affected significantly by water stress, genotypes, and genotypes by water stress interactions (Farhat, 2009)

It is quite useful and illustrative to express all components of variance in percentages, which show the relative contribution of each source to the total variance (Table 4). The mean squares of irrigation regimes explained most of the total variation for most characters in the two seasons, indicating the relative importance of irrigation treatments in breeding programs for water stress tolerance. A similar trend of results was found by Mohammadi et al. (2011), and Abd El-Mohsen et al. (2015). In addition, Solomon et al. (2008) obtained a dominant effect of the environment over that of the genotypes for yield of 23 wheat genotypes across 12 environments. Moreover, the high importance of variances due to genotypes compared with those of interactions between genotypes and water regimes for most characters indicate that the studied genotypes had the same and fixed relative performance and in general, some genotypes were superior in all conditions.

2) Means performance and water stress susceptibility index:

In respect to the means of all genotypes, these means significantly decreased for most characters in the two seasons under reduced irrigation. In addition, the maximum and minimum values for the studied characters went in the same trend for the overall means and decreased under reduced irrigation in the two seasons. Moreover, the ranges between the maximum and minimum values of all characters deceased under the reduced irrigation in the two seasons in most cases. Plant water stresses affect most physiological processes in wheat and may lead to reduce plant growth by affecting various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters (Jaleel et al., 2008). In general, these results are in harmony with those reported by Farhat (2009), and Abdelraouf et al. (2013).

The daily air temperatures were low in the second season than the first season (Table 2). These conditions represented more suitable growth condition and allowed the genotypes to express their genetic maximum potential. The means of all genotypes in the second season were higher than those in the first season under normal and reduced irrigation for most characters (Table 5). The primary variable influencing phasic development rate is temperature (Iglesias, 2006) and consequently reduce the most agronomic characters. In general, these results are in line with those of Hassanein et al. (2012); and Rahmani et al. (2013).

Moreover, Line 1, Line 2 and Line 3 were the earliest genotypes for heading and maturity and could be used as source of earliness in breeding program.

Magnitude of yield depression is perhaps the most practiced measure of water stress tolerance of wheat plant (Foulkes et al., 2004). The stress susceptibility index (SSI) estimates the rate of change for each genotype in yield between the stress and non-stress conditions relative to the mean change for all genotypes. Regardless of the low grain yield potentiality, Cham 4 then Sakha 93 were the most tolerant genotypes to water stress in the two seasons and could be used as source of water stress tolerance in breeding programs, while Gemmeiza 9 was vice versa.

The three dimensional plots (Fig. 1) separated the genotypes into 4 groups: high yielding under both normal and water stress (Group A), high yielding under normal (Group B) or water stress (Group C), and low yielding under both water regimes (Group D). Based on results of each of the three dimensional plots (Fig. 1) and stress susceptibility index (Table 5), Sakha 94 had the advantages of the two breeding strategies for water stress i.e. high yield potential and water stress tolerance and hence recommended to be used as parents for genetic analysis and improvement of water stress tolerance in wheat breeding programs. According to Nawaz et al. (2013), a water stress tolerant genotype yields significantly higher than average compared with other genotypes of the same species under water stress. On the other hand, Misr 1, Misr 2, Sids 13 and Shandweel 1 showed the highest yield potentiality and were susceptible to water stress, consequently could be used as source for yield potential improvement. The same trend was observed for Gemmeiza 9 and Line 1 under normal irrigation in the two seasons. Meanwhile, the opposite results were reported for Sids 12 in the two seasons, since showed low yield potential and was susceptible to water stress. The remaining genotypes had year-to-year variation in grain yield potentiality and stress susceptibility index. More studies for another years are needed for more reliability on these fluctuating results. In addition, Abd El-Mohsen et al. (2015) found that Sids 1, Sham 10, Sham 8 and Sahel 1 were identified as the most water stress tolerant from ten studied bread wheat genotypes. Generally, some water stress tolerant- genotypes are not necessarily to be the highest in yield potentiality under this study.

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استجابة ٢١ تركيب وراثي من قمح الخبز الربيعي للري العادي والمخفض في شمال الدلتا

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أُجريت هذه الدراسة لتقييم ٢١ تركيبًا وراثيا من قمح الخبز تتضمن ١٣ صنفًا مصريًّا تحت الري العادي (خمس ريات) والري المخفض (رية الزراعة فقط) في موسمي ٢٠١٠/٢٠١١ و٢٠١١/٢٠١٢. وكانت الصفات المدروسة هي: عدد الأيام حتى طرد السنابل والنضج، مدة ومعدل امتلاء الحبوب، ارتفاع النبات، المحصول الكلي ومحصول الحبوب والتبن، دليل الحصاد، عدد السنابل في المتر المربع، عدد حبوب السنبلة ووزن الحبة بالإضافة لمعامل الحساسية للإجهاد. كانت التباينات الراجعة إلى التراكيب الوراثية معنوية في كل الظروف، وكانت أعلى تحت ظروف الري العادي بالمقارنة بالري المخفض، مما يعني قاعدة وراثية متباينة وأداء وراثي أفضل تحت الري العادي. وكانت التباينات الناتجة عن معاملتي الري والأصناف والتفاعل بين الأصناف ومعاملتي الري معنوية في معظم الحالات. وكان الإسهام الأكبر في هذه التباينات يرجع لمعاملتي الري ثم الأصناف مما يعني أهمية تقييم التراكيب الوراثية تحت كل من معاملات الري العادي والمخفض. وكانت تباينات التراكيب الوراثية أعلى من تباينات التفاعل بين التراكيب الوراثية والري في معظم الحالات. وقد انخفض المتوسط العام لكل الأصناف تحت الري المخفض لمعظم الصفات المدروسة. وظهر أكبر وأقل متوسط فقد نتيجة الري المخفض في الموسمين في صفتي عدد السنابل في المتر المربع ودليل الحصاد، على التوالي. وكانت السلالات رقم ١، ٢ و٣ الأكثر تبكيرا بين التراكب الوراثية تحت كل الظروف، مما يُنصح معه باستخدامها في برنامج التربية للتبكير. وقد كان هناك انخفاض ملحوظ في درجات الحرارة اليومية في الموسم الثاني مقارنة بالموسم الأول، مما تسبب في انخفاض تباينات التراكيب الوراثية وزيادة المتوسط العام للتراكيب الوراثية لمعظم الصفات في الموسم الثاني. وقد زاد متوسط الفقد في معظم الصفات نتيجة الري المخفض في الموسم الثاني بالمقارنة بالموسم الأول. كان التركيبان الوراثيان شام ٤ وسخا ٩٣ الأكثر تحملا لنقص الري في الموسمين بغض النظر عن محصول الحبوب لهما، مما يجعلهما مصدرا مهما للتربية لتحمل الإجهاد المائي، بينما ظهر العكس في الصنف جميزة ٩. وقد جمع الصنف سخا ٩٤ بين تحمل الإجهاد المائي والمحصول العالي في كل الظروف مما يرشحه كأب في برنامج التربية لتحمل الإجهاد المائي بالإضافة إلى القدرة الإنتاجية المرتفعة. بينما تميزت أصناف مصر ١، مصر٢، سدس ١٣ وشندويل ١ بالمحصول العالي والحساسية للإجهاد المائي، مما يرشحها للاستخدام في التربية للمحصول المرتفع فقط. وقد جمع الصنف سدس ١٢ بين القدرة الإنتاجية المنخفضة مقارنة ببقية التراكيب الوراثية المدروسة والحساسية للإجهاد المائي. بينما اختلف سلوك التراكيب الوراثية الأخرى بالنسبة للقدرة الإنتاجية وتحمل الإجهاد المائي خلال الموسمين مما يحتاج معه إلى تأكيد النتائج بمزيد من الدراسات. بصفة عامة، لم يوجد تلازم بين تحمل بعض التراكيب الوراثية للإجهاد وارتفاع قدرتها الإنتاجية وذلك تحت ظروف هذه الدراسة.

Table 3: Mean squares and coefficients of variation (CV) of the studied characters under the two irrigation regimes (normal, N and reduced irrigation, S) across 2010/2011 and 2011/2012 seasons.

SOV	Df	Season	Water regime	Days to heading	Days to maturity	Grain filling period	Grain filling rate	Plant height	Biological yield	Grain yield	Straw yield	Harvest index	No. of spikes m^{-2}	No. of kernels per spike	1000-kernel weight
Replications	5	2010/2011	N	31.2	17.5	10.0	2.2	30.1	0.051	0.010	0.058	0.003	4609.9	20.1	10.2
			S	11.3	7.1	23.0	9.9	22.8	0.291	0.054	0.113	0.001	38397.8	17.9	1.9
		2011/2012	N	0.5	6.4	7.5	7.2	22.2	0.060	0.011	0.093	0.005	5363.6	5.3	169.7
			S	0.7	7.1	4.9	3.4	20.3	0.157	0.010	0.165	0.008	34450.0	70.7	12.4
Genotypes	20	2010/2011	N	148.8**	54.7**	60.3**	46.0**	587.8**	0.613**	0.077**	0.337**	0.006**	24894.6**	213.2**	218.7**
			S	134.2**	55.8**	69.4**	36.6**	589.1**	0.434**	0.037**	0.286**	0.007**	27832.4**	209.4**	218.9**
		2011/2012	N	47.4**	30.6**	14.5**	30.6**	461.4**	0.175**	0.074**	0.103*	0.007**	14928.3**	171.3**	180.7**
			S	22.6**	18.5**	10.7**	12.4**	426.9**	0.315**	0.026**	0.241**	0.009**	12125.4**	199.2**	148.6**
Error	100	2010/2011	N	2.3	1.9	3.1	4.1	20.8	0.071	0.012	0.041	0.001	7164.1	22.2	4.8
			S	2.2	2.7	3.0	3.9	22.2	0.058	0.011	0.029	0.001	5416.7	13.7	1.4
		2011/2012	N	4.4	2.3	3.4	4.4	11.5	0.054	0.011	0.053	0.003	5054.8	35.2	10.3
			S	3.6	1.6	1.9	3.6	14.9	0.067	0.008	0.065	0.004	5280.0	27.0	7.9
Total		125													
CV	2010/2011		N	1.7	1.0	3.5	10.4	4.1	10.8	10.6	14.0	7.5	17.6	8.4	4.7
			S	1.7	1.2	3.4	10.3	4.5	10.7	10.8	13.2	6.6	17.5	6.8	2,5
	2011/2012		N	1.2	1.0	3.6	9.5	3.1	9.2	9.3	16.4	11.7	14.3	9.9	6.7
			S	0.7	0.9	2.9	9.1	3.7	11.1	9.1	19.3	13.4	16.3	9.1	6.4

***, ** Significant at 0.05 and 0.01 levels of probability, respectively.**

Table 4: Mean squares (MS) and variance components in percentage (VC) of the studied characters over the two water regimes in seasons 2010/2011 and 2011/2012.

SOV	Df	Season	Days to heading		Days to maturity		Grain filling period		Grain filling rate		Plant height		Biological yield	
			MS	VC	MS	VC	MS	VC	MS	VC	MS	VC	MS	VC
Irrigation (Irr)	1	2010/2011	28.0	9.01	213.1**	65.87	181.7**	58.35	7.1	7.92	3015.8**	71.93	2.965**	73.88
		2011/2012	-	-	3066.0**	98.43	-	-	99.0**	69.72	1525.4**	63.20	2.401**	83.08
Replication/Irr = (Ea)	10	2010/2011	21.3		12.3		16.5		6.1		26.4		0.171	
		2011/2012	-		6.7		-		5.3		21.3		0.109	
Genotypes (Geno)	20	2010/2011	281.0**	90.38	104.6**	32.33	124.9**	40.11	72.0**	80.27	1142.3**	27.25	0.954**	23.77
		2011/2012	-	-	44.8**	1.44	-	-	36.7	25.85	871.7**	36.11	0.424**	14.67
Geno x Irr	20	2010/2011	1.9*	0.61	5.8**	1.79	4.8	1.54	10.6**	11.82	34.6*	0.82	0.094	2.34
		2011/2012	-	-	4.2**	0.13	-	-	6.3	4.44	16.6	0.69	0.065	2.25
Error/Irr (Pooled error)	200	2010/2011	2.2		2.3		3.0		4.0		21.5		0.065	
		2011/2012	-		2.0		-		4.0		13.2		0.060	
Total	251													

SOV	Df	Season	Grain yield		Straw yield		Harvest index		No. of spikes m^{-2}		No. of kernels per spike		1000-kernel weight	
			MS	VC	MS	VC	MS	VC	MS	VC	MS	VC	MS	VC
Irrigation (Irr)	1	2010/2011	0.162*	58.48	1.742**	73.66	0.021**	61.76	226755.1*	81.13	-	-	-	-
		2011/2012	0.753**	88.38	0.465	57.41	0.002	11.11	167005.9**	86.08	533.8*	59.02	1139.3**	77.58
Replication/Irr = (Ea)	10	2010/2011	0.032		0.085		0.002		21503.9		-		-	
		2011/2012	0.011		0.129		0.006		19906.8		38.0		91.0	
Genotypes (Geno)	20	2010/2011	0.082**	29.60	0.589**	24.90	0.011**	32.35	44620.9**	15.97	-	-	-	-
		2011/2012	0.079**	9.27	0.207**	25.56	0.005*	27.78	24017.4**	12.38	350.5**	38.75	318.8**	21.71
Geno x Irr	20	2010/2011	0.033**	11.91	0.034	1.44	0.002*	5.88	8106.1	2.90	-	-	-	-
		2011/2012	0.020**	2.35	0.138**	17.04	0.011**	61.11	3036.2	1.56	20.1*	2.22	10.4	0.71
Error/Irr (Pooled error)	200	2010/2011	0.011		0.035		0.001		6290.4		-	-	-	-
		2011/2012	0.010		0.059		0.003		5167.4		31.1	59.02	9.1	77.58
Total	251													

***, ** = Significant at 0.05 and 0.01 levels of probability, respectively.**

Table 5: Cont.

Genotype	Grain yield (kg m^{-2})				No. of spikes m^{-2}				No. of kernels per spike				1000-kernel weight			
	2010/2011		2011/2012		2010/2011		2011/2012		2010/2011		2011/2012		2010/2011		2011/2012	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Giza 168	1.01	0.87	1.14	0.98	505.00	423.89	520.56	430.00	54.44	55.20	56.71	52.04	44.97	41.62	43.91	40.52
Sakha 93	0.82	0.90	0.93	0.97	433.33	408.89	499.44	420.00	48.44	48.45	51.13	50.30	46.71	47.83	48.25	45.48
Sakha 94	1.02	1.08	1.16	1.06	466.67	445.56	461.67	430.56	57.27	54.73	62.10	61.96	43.46	45.60	46.48	44.34
Misr 1	1.20	1.08	1.29	1.16	470.00	406.67	486.11	417.22	54.28	50.45	61.46	59.78	49.55	48.00	49.50	45.16
Misr 2	1.19	1.09	1.23	1.06	526.67	426.67	558.89	483.89	60.67	61.90	58.27	54.43	43.79	44.04	45.41	41.73
Gemmeiza 7	0.94	0.88	1.14	0.97	348.89	310.00	482.33	408.33	55.00	52.90	62.43	56.60	50.47	51.12	55.60	46.99
Gemmeiza 9	1.21	0.92	1.18	0.93	516.11	350.00	461.11	445.00	55.69	53.14	55.58	53.51	46.27	45.92	50.06	42.03
Gemmeiza 10	1.00	0.93	1.17	1.06	468.33	384.00	498.89	476.67	58.01	54.91	59.36	54.83	44.84	44.32	45.86	40.79
Gemmeiza 11	1.02	0.95	1.19	1.04	359.44	318.33	411.11	373.33	60.61	57.83	64.37	64.70	56.67	56.71	57.98	52.90
Sids 1	1.01	1.10	1.18	1.06	481.11	482.67	531.67	520.00	52.46	45.98	59.23	52.14	47.81	47.13	49.75	44.07
Sids 12	0.97	0.91	1.09	0.95	498.89	335.56	396.67	395.00	61.44	61.81	64.48	62.52	48.74	48.66	47.16	42.31
Sids 13	1.19	1.01	1.25	1.09	562.78	417.78	575.00	486.11	64.21	63.07	64.20	60.49	41.17	40.88	43.43	37.71
Shandweel 1	1.11	1.03	1.12	1.11	465.56	415.56	509.44	430.00	60.78	60.99	69.93	68.54	44.24	43.43	42.07	38.40
Line 1	1.16	0.98	1.15	1.03	421.40	376.42	483.33	403.33	65.24	53.82	66.68	60.61	55.53	54.56	54.21	49.04
Line 2	0.92	0.89	1.08	1.02	380.00	362.78	492.83	401.11	47.76	45.91	51.80	45.80	59.38	59.00	61.51	57.72
Line 3	0.86	0.93	1.01	0.97	516.42	519.86	506.67	487.78	41.86	42.25	48.67	47.86	54.44	53.48	50.42	47.30
Line 4	1.06	1.04	1.12	1.00	531.67	470.00	412.22	408.94	53.70	52.68	62.33	54.32	46.64	46.02	49.42	44.97
Cham 4	0.93	1.09	0.82	0.90	581.67	583.33	538.33	500.00	52.09	52.38	58.06	57.33	37.67	37.67	42.53	39.30
Cham 6	0.98	0.97	0.97	0.95	567.78	456.67	563.89	507.78	55.81	55.87	56.00	56.07	39.09	38.60	42.44	42.20
Cham 8	1.04	0.94	1.20	1.03	520.56	495.56	552.22	521.67	65.68	64.21	64.81	62.59	38.41	38.28	40.69	37.22
Cham 10	0.93	0.90	1.17	0.95	473.89	446.11	527.78	442.22	56.53	56.63	61.27	61.30	40.96	40.13	45.56	42.75
Maximum	1.21	1.10	1.29	1.16	581.67	583.33	575.00	521.67	65.68	64.21	69.93	68.54	59.38	59.00	61.51	57.72
Minimum	0.82	0.87	0.82	0.90	348.89	310.00	396.67	373.33	41.86	42.25	48.67	45.80	37.67	37.67	40.69	37.22
Range	0.393	0.227	0.467	0.259	232.78	273.33	178.33	148.33	23.82	21.95	21.27	22.74	21.71	21.33	20.81	20.49
Means	1.026	0.975	1.123	1.014	480.77	420.78	498.58	447.09	56.28	54.53	59.95	57.03	46.70	46.33	48.20	43.95
$LSD_{0.05}$	0.124	0.120	0.120	0.105	96.76	84.13	81.28	83.07	5.39	4.23	6.78	5.94	2.50	1.33	3.67	3.21

Table 5: Cont.

Genotype	Plant height (cm)				Biological yield (kg m^{-2})				Straw yield (kg m^{-2})				Harvest index (%)			
	2010/2011		2011/2012		2010/2011		2011/2012		2010/2011		2011/2012		2010/2011		2011/2012	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Giza 168	105.83	95.83	105.83	99.17	2.31	1.87	2.34	2.28	1.30	1.00	1.21	1.30	0.44	0.47	0.49	0.43
Sakha 93	98.33	90.00	98.33	95.00	1.93	1.91	2.33	1.98	1.12	1.02	1.41	1.01	0.42	0.47	0.40	0.49
Sakha 94	118.33	114.79	118.33	109.17	2.46	2.44	2.50	2.29	1.44	1.35	1.34	1.23	0.41	0.44	0.47	0.47
Misr 1	112.50	106.67	111.67	105.83	2.86	2.41	2.70	2.63	1.66	1.32	1.41	1.48	0.42	0.45	0.48	0.44
Misr 2	127.50	115.83	118.33	111.77	2.98	2.54	2.56	2.42	1.80	1.45	1.33	1.36	0.40	0.43	0.48	0.44
Gemmeiza 7	121.67	116.67	123.33	118.33	2.58	2.30	2.49	2.42	1.64	1.42	1.35	1.45	0.36	0.39	0.46	0.40
Gemmeiza 9	120.83	105.00	115.83	110.00	2.97	2.56	2.66	2.64	1.76	1.64	1.48	1.71	0.41	0.36	0.44	0.35
Gemmeiza 10	100.00	95.00	100.00	96.67	2.38	2.12	2.62	2.28	1.38	1.19	1.45	1.22	0.42	0.44	0.45	0.47
Gemmeiza 11	115.00	109.17	114.17	111.67	2.49	2.32	2.63	2.41	1.47	1.37	1.44	1.37	0.41	0.41	0.46	0.44
Sids 1	121.67	115.00	125.00	118.33	2.88	2.87	2.92	2.59	1.87	1.77	1.74	1.53	0.35	0.38	0.41	0.41
Sids 12	105.00	95.00	106.67	97.50	2.21	1.97	2.26	2.23	1.24	1.06	1.17	1.29	0.44	0.47	0.49	0.43
Sids 13	97.50	91.67	104.17	97.50	2.52	2.12	2.69	2.41	1.34	1.11	1.44	1.32	0.47	0.48	0.47	0.46
Shandweel 1	115.00	105.00	111.67	106.67	2.87	2.43	2.76	2.57	1.76	1.39	1.64	1.45	0.39	0.43	0.41	0.44
Line 1	118.95	118.40	121.67	116.67	2.55	2.13	2.62	2.58	1.39	1.16	1.47	1.55	0.45	0.46	0.45	0.40
Line 2	115.00	107.50	113.33	108.33	2.28	2.11	2.46	2.18	1.36	1.22	1.38	1.16	0.40	0.42	0.44	0.48
Line 3	95.00	92.97	100.83	95.00	1.84	1.82	2.39	1.91	0.97	0.89	1.37	0.94	0.47	0.51	0.42	0.51
Line 4	122.50	118.33	120.83	120.00	2.63	2.59	2.61	2.42	1.58	1.55	1.48	1.42	0.40	0.40	0.43	0.41
Cham 4	100.83	95.00	98.33	98.33	2.39	2.39	2.34	1.84	1.47	1.31	1.52	0.95	0.39	0.45	0.35	0.49
Cham 6	105.00	96.67	101.67	99.17	2.36	2.33	2.30	2.11	1.38	1.36	1.33	1.16	0.42	0.42	0.43	0.46
Cham 8	101.67	95.00	103.33	100.00	2.33	2.15	2.52	2.40	1.29	1.21	1.33	1.37	0.45	0.44	0.48	0.43
Cham 10	103.33	96.67	103.33	98.33	2.11	2.04	2.43	2.42	1.18	1.14	1.26	1.48	0.44	0.44	0.48	0.41
Maximum	127.50	118.40	125.00	120.00	2.98	2.87	2.92	2.64	1.87	1.77	1.74	1.71	0.47	0.51	0.49	0.51
Minimum	95.00	90.00	98.33	95.00	1.84	1.82	2.26	1.84	0.97	0.89	1.17	0.94	0.35	0.36	0.35	0.35
Range	34.17	28.40	26.67	25.00	1.148	1.048	0.667	0.794	0.896	0.879	0.571	0.768	0.121	0.149	0.136	0.161
Means	110.55	103.63	110.32	105.40	2.473	2.257	2.530	2.335	1.447	1.281	1.407	1.321	0.418	0.436	0.447	0.442
$LSD_{0.05}$	5.25	5.39	4.01	4.50	0.305	0.276	0.265	0.296	0.231	0.194	0.264	0.291	0.036	0.033	0.060	0.068

Table 5: Means of the studied characters for the 21 studied genotypes under normal (N) and reduced irrigation (S) across seasons 2010/2011 and 2011/2012.

Genotype	Days to heading				Days to maturity				Grain filling period (days)				Grain filling rate (g m^{-2} day^{-1})			
	2010/2011		2011/2012		2010/2011		2011/2012		2010/2011		2011/2012		2010/2011		2011/2012	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Giza 168	85.33	84.50	96.83	94.67	143.00	141.17	150.83	144.00	57.67	56.67	54.00	49.33	17.45	15.34	21.10	19.93
Sakha 93	82.83	82.17	97.33	93.50	141.83	140.17	150.83	143.50	59.00	58.00	53.50	50.00	13.83	15.45	17.45	19.36
Sakha 94	93.17	93.58	99.50	94.33	141.83	139.96	149.67	141.83	48.67	46.38	50.17	47.50	21.05	23.31	23.17	22.42
Misr 1	89.83	89.67	97.33	93.50	140.33	136.17	148.67	141.33	50.50	46.50	51.33	47.83	23.84	23.29	25.12	24.18
Misr 2	94.50	91.83	99.17	94.33	145.50	140.50	150.50	143.67	51.00	48.67	51.33	49.33	23.25	22.51	23.89	21.51
Gemmeiza 7	89.00	87.50	100.67	95.17	140.00	137.83	150.83	143.50	51.00	50.33	50.17	48.33	18.44	17.55	22.76	20.11
Gemmeiza 9	95.33	93.83	102.67	100.33	144.83	141.83	152.67	146.83	49.50	48.00	50.00	46.50	24.40	19.21	23.53	20.05
Gemmeiza 10	91.67	92.00	102.50	95.67	143.33	140.60	152.00	144.33	51.67	48.60	49.50	48.67	19.37	19.12	23.69	21.83
Gemmeiza 11	83.50	83.17	99.00	94.50	139.50	137.83	150.17	143.17	56.00	54.67	51.17	48.67	18.17	17.38	23.22	21.41
Sids 1	90.50	90.20	101.00	94.67	141.17	139.20	151.17	144.17	50.67	49.00	50.17	49.50	20.04	22.37	23.61	21.47
Sids 12	82.33	82.33	96.33	93.33	138.67	137.50	149.00	142.00	56.83	54.50	52.67	48.67	17.02	16.72	20.62	19.45
Sids 13	91.33	91.33	99.17	93.83	142.50	139.50	150.50	142.00	51.17	48.17	51.33	48.17	23.20	20.87	24.36	22.55
Shandweel 1	86.17	86.00	100.50	94.67	142.00	139.83	152.00	146.00	55.83	53.83	51.50	51.33	19.80	19.18	21.74	21.68
Line 1	82.36	82.27	98.50	93.83	137.45	137.41	149.67	142.50	55.93	54.14	51.17	48.67	20.74	17.99	22.46	21.16
Line 2	80.33	79.33	92.50	92.17	137.00	132.17	144.17	141.00	56.67	52.83	51.67	48.83	16.22	16.83	20.85	20.88
Line 3	82.57	82.55	98.33	92.50	134.74	134.36	147.17	140.83	53.00	52.81	48.83	48.33	16.28	17.55	20.78	20.15
Line 4	93.17	91.83	102.00	98.33	141.50	139.17	149.83	143.33	48.33	47.33	47.83	45.00	21.91	21.94	23.48	22.18
Cham 4	95.17	93.00	106.33	98.00	147.17	144.83	155.17	147.17	52.00	51.83	48.83	49.17	17.79	20.94	16.89	18.26
Cham 6	93.33	92.50	101.00	94.17	144.33	144.33	153.83	144.83	51.00	51.83	52.83	50.67	19.22	18.71	18.51	18.82
Cham 8	91.83	91.17	100.33	94.17	142.50	138.83	150.33	142.50	50.67	47.67	50.00	48.33	20.50	19.69	23.93	21.34
Cham 10	93.00	92.50	99.33	94.83	144.50	143.67	149.83	143.83	51.50	51.17	50.50	49.00	18.03	17.55	23.24	19.31
Maximum	95.33	93.83	106.33	100.33	147.17	144.83	155.17	147.17	59.00	58.00	54.00	51.33	24.40	23.31	25.12	24.18
Minimum	80.33	79.33	92.50	92.17	134.74	132.17	144.17	140.83	48.33	46.38	47.83	45.00	13.83	15.34	16.89	18.26
Range	15.00	14.50	13.83	8.17	12.43	12.67	11.00	6.33	10.67	11.63	6.17	6.33	10.57	7.97	8.23	5.92
Means	88.92	88.25	99.54	94.79	141.60	139.37	150.42	143.44	52.79	51.09	50.88	48.66	19.55	19.21	22.11	20.86
$LSD_{0.05}$	1.74	1.69	1.35	0.74	1.57	1.87	1.74	1.47	2.01	1.98	2.12	1.59	2.32	2.27	2.40	2.18