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Evaluation of Several New Bread Wheat Genotypes (*Triticum aestivum L.*) for Grain Yield and Its Components under Water Stress Conditions

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Abstract:

Two experiments were conducted at the Agriculture Experimental Research Farm of the Faculty of Agriculture, Assiut University, in each of the two seasons 2011/2012 and 2012/2013. The first experiment was irrigated as needed (normal), while the second one irrigated only one time three weeks after sowing irrigation (drought stress). This work aims to evaluate 30 wheat genotypes (*Triticum aestivum* L.) and two check cultivars, namely, Giza 168 and Sakha 93 under normal irrigation and drought stress conditions. Separate analysis of variance revealed highly significant differences between the evaluated genotypes for all studied traits in the two seasons under each environment. Combined analysis of variance over seasons and environments revealed highly significant differences between seasons for no. of spikes/ plant and grain yield/plant. The mean squares due to environments, genotypes, (G x S) and (G x E) interactions were highly significant for all studied traits whereas the mean squares due to (G x S x E) interactions were highly significant for no. of spikes/ plant and grain yield/plant. Drought stress reduced spike length, number of spikes/plant, number of grainss/spike, 1000-grain weight and grain yield/plant by 5.04, 18.38, 9.40, 11.15 and 25.07%, respectively. The new genotypes Assiut 216, Assiut 238, Assiut 228, Assiut 726 and R 80 highly significantly surpassed the two check cultivars in grain yield/plant and some of correlated traits. The new genotypes Assiut 224, Assiut 248, Assiut 249, Assiut 406, Assiut 704 and MK 2-27 showed drought Susceptibility Index less than one and were considered tolerant to drought stress. It could be concluded that these genotypes can be used in wheat breading programs to improve grain yield and drought tolerance.

Keywords: (*Triticum aestivum* L.), drought susceptibility index.

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Introduction:

It is well known that wheat is one of the most important major cereal crops in the world and the most strategic food crop in Egypt. The total wheat production in 2012 season was 8.79 million metric tons (F.A.O Statistic Year Book, 2012). Annually consumption increase than production is due to the increase in population and relies on bread as the main staple. Drought is a major stress factor which limits crop production in most areas of a world. Developing crop cultivars with high yield potentials through identifying drought tolerance mechanisms is important for increasing yields in dry areas (Fischer and Maurer, 1978 and Rajaram *et al*., 1996). Developing high-yielding wheat cultivars under drought conditions in arid and semi-arid regions is an important objective of breeding programs (Leilah and Al-Khateeb 2005).

Wheat production under rainfed or minimum irrigation conditions becomes an objective in Egypt as well as many areas world wide due to increasing limitations of water supply. Breeding wheat cultivars with improved drought tolerance is a challenge due to inadequate screening and tolerance quantification procedures. Drought stress may reduce all yield components, particularly the number of fertile spikes/unit area and the number of grains/spike (Giunta *et al*., 1993; Simane *et al*., 1993; Abayomi and Wright, 1999). While natural selection has favoured mechanisms for adaptation and survival, breeding activity has directed selection towards increasing the economic yield of cultivated species. More than 80 years of breeding activities have led to some yield increase in drought environments for many crop plants. Meanwhile, fundamental research has provided significant gains in the understanding of the physiological and molecular responses of plants to water deficits, but there is still a large gap between yields in optimal and stress conditions. Minimizing the yield gap and increasing yield stability under deferent stress conditions are of strategic importance in guaranteeing food for the future (Cattivelli *et al.,* 2008). The objective of the present investigation is the evaluation of several wheat genotypes for drought tolerance.

Materials and Methods:

Laboratory and field experiments were carried out at the Agriculture Experimental Research Farm of the Faculty of Agriculture, Assiut University, in the two seasons 2011/2012 and 2012/2013. The wheat genotypes used in this study under normal irrigation and drought stress conditions are presented in (Table 1).

The first experiment was irrigated as normal, while the second one matched only one time three weeks after sowing irrigation as drought stress. A randomized complete block design with four replications was used in the two seasons. Grains were sown in rows 3 m long and 30 cm apart. Sixty grains were sown in each row. Each genotype was represented by one row in each replication.

Data were recorded on a random sample of five plants from each row to calculate spike length (cm), no. of spikes /plant, no. of grains/spike, 1000 grain weight (g) and Grain yield/plant (g).

Statistical analysis:

The separate as well as combined analysis of variance for different characters was done on plot mean basis after testing the homogeneity of errors by using (Bartlett's test 1937) according to Gomez and Gomez (1984). Revised L.S.D at 5% levels was used to compare means according to (Waller and Duncan 1969).

Drought susceptibility index (DSI); was calculated according to the method of Fischer and Maurer (1978). Yield of individual genotype was determining under stress (Y_d) and favorable well-water (Y_P) conditions.

Table (1): The pedigree of the evaluated genotypes.

Serial No.	Designed Name	Pedigree
1	Assiut 108	(PI 383303 Rageni X CI 4397-EMERALD)
2	Assiut 216	(Local 562 X 5500-10-21/29)
3	Assiut 217	(134 X S.69-186/3/368/1) x (5500-10-21/29)
4	Assiut 224	CI4397-EMERALT) x (134 X S.69-186/3/368/1)
5	Assiut 230	(KVZ/Buha"S" Kal /Bb) X (134 X S.69-186/3/368)
6	Assiut 238	(KVZ/Buha"S" Kal /Bb) X (PI 137743 CANDUMI-Iran)
7	Assiut 241	(134 X S.61-376/1 X 5500-10-21/29)
8	Assiut 248	(KVZ/Buha"S" Kal /Bb) X (134 X S.69-186/3/368/1)
9	Assiut 249	(KVZ/Buha"S" Kal /Bb) X (134 X S.69-186/3/368/7)
10	Assiut 406	(KVZ/Buha"S" Kal /Bb X 5500-10-21/29)
11	Assiut 704	(Genaro 81X L. 2052)
12	Assiut 228	(T.aestivum / Bon // Cno / 7CCM33009 x 5500-10-21/29)
13	Assiut 724	(Shenab 70 X G.155) X (5500-10-21/29)
14	Assiut 725	(Shenab 70 X G.155) X (5500-10-21/29)
15	Assiut 726	(Vem // Cno67/7c/3/Kal/Bh X 5500-10-21/29)
16	Assiut 733	(Vem // Cno67/7c/3/Kal/Bh X 5500-10-21/29)
17	Mubark	PI383308 Rageni 15(Mutant), Pakistan
18	MK 1-1	Maxi pack X 5500-10-21/29
19	MK 7-15	134-S61 // 193 / 4 / 378 / 2 x 5500-10-21/29
20	Assiut 401	(KVZ/Buha"S" Kal /Bb X Solanika)
21	Sel 542	(Baka nora 88 X Inia / RI 4220 // 7C/ Yr "S")
22	MK 1-10	Maxi pack X 5500-10-21/29
23	Mk 1-16	Maxi pack X 5500-10-21/29
24	Mk 1-20	Maxi pack X 5500-10-21/29
25	Mk 2-27	(134-S69 // 201/ 3 / 392 / 1 x 5500-10-21/29)
26	Mk 2-29	(134-S69 // 201/ 3 / 392 / 1 x 5500-10-21/29)
27	Mk 7-81	(134-S61 // 193/ 4/ 378 / 2 x 5500-10-21/29)
28	Mk 7-83	(134-S61 // 193/ 4/ 378 / 2 x 5500-10-21/29)
29	R 80	(KVZ/Buha"S" Kal /Bb X YT54/N10 B//2 Y54)
30	F6 118	(KVZ/Buha"S" Kal /Bb X Tokwei (S. Africa))
31	Giza 168	MIL/Buc//Seri CM93046-8M-O4-OM-2Y-OB
32	Sakha 93	SAKHA 92 x TR 810328

Average yield of all genotypes under drought ($\overline{Y}_d$) and well-watered conditions ($\overline{Y}_p$) were used to calculate drought intensity (D) as: $D = 1 - \overline{Y}_d / \overline{Y}_p$.

The mean drought susceptibility index (S) of individual genotype was calculated as: $S = (1 - Y_d / Y_P)/D$

Genotypes with average susceptibility or tolerance to drought have "S" value of 1.0 and less than 1.0 indicate less susceptibility and great tolerance to drought. Meanwhile, a value of S = 0.0 indicates maximum possible drought tolerance (no effect of drought on yield). While genotypes having more than one are considered to be susceptible.

Results and Discussion:

A-Performance of bread wheat genotypes under normal irrigation and water stress conditions

Separate analysis of variance for the studied traits in each of the two seasons under normal irrigation and drought stress environments is presented in Table 2. There are highly significantly differences between the evaluated genotypes for all the studied traits. Combined analysis of variance over seasons and environments revealed highly significant differences among seasons for no. of spikes/ plant and grain yield/plant. The mean squares due to environments, genotypes, G x S and G x E interactions were highly significant for all studied traits except spike length was significant only whereas, mean squares due to G x S x E interactions were highly significant for no. of spikes/ plant and grain yield/plant, (Table 3).

Spike length:

The combined average over seasons of spike length under normal irrigation condition ranged from 11.58 cm for Assiut 108 to 16.10 cm for Assiut 726 with an average of 13.88 cm. Twenty two genotypes highly significantly surpassed G.168 in spike length. Under drought condition, spike length ranged from 10.48 for Assiut 108 to 14.90 for Assiut 726 with an average of 13.18 cm. Nineteen new genotypes surpassed highly significantly G.168 in spike length, (Table 4).

The new genotypes, i.e. Assiut 224, Assiut 248, Assiut 249, Assiut 724, Assiut 725, Assiut 726, Assiut 733, Sel. 542, MK 1-20, MK 2-27, MK 2-29, MK 7-81 and MK 7-83 gave highly significantly long spikes compared to Giza 168 over all irrigation treatments and seasons. These genotypes could be used to improve spike length and consequently grain yield in wheat breeding programs, (Table 4).

The reduction in spike length due to water stress in the two seasons was 5.04% compared to normal irrigation condition. Abd El-Kerrim (1991) found that spike length was significantly affected by planting date, water stress treatments and wheat genotypes. Saleem (2003) reported that spike length was decreased by water stress in both durum and bread wheat genotypes. Kheiralla *et al.* (2004) reported that spikes length were highly significantly affected by years, water stress treatments and genotypes. Exposing wheat plants to drought at tillering, booting and milk stages reduced spike length by 7.50 12.36 and 7.49%, respectively compared to normal irrigation.

No. of spikes/plant

The combined average over seasons for no. of spike/plant under normal irrigation condition ranged from 6.19 for Assiut 724 to 11.15 for R 80 with an average of 8.00. Nine new genotypes highly significantly surpassed G.168 in no. of spike/plant.

The average no. of spikes/plant of the genotypes, i.e. Assiut 216, Assiut 217, Assiut 228, Assiut 401, MK 7-15 and R80 significantly surpassed that of G168 by 29.00% and Sakha 93 by 55.90%. Under drought condition, no. of spikes/plant ranged from 4.93 for Assiut724 to 9.33 for R 80 with an average of 6.53. Three new genotypes highly significantly surpassed G.168 in no. of spikes/plant, (Table 5).

The new genotypes, i.e. Assiut 216, Assiut 217, Assiut 238, Assiut 228, Assiut 401 and R80 highly significantly surpassed the chick cultivar G.168 in no. of spikes/plant. These genotypes could be used to improve no. spikes/plant and consequently grain yield in wheat breeding programs, (Table 5).

The reduction in no. of spikes/plant due to water stress was 18.38% compared to normal irrigation condition. Kheiralla *et al*. (1997) also drought stress caused a significant reduction in no. of spikes/plant by 41.82% and 15.10% (Kheiralla *et al*. 2004). Moreover, Tawfelis (2006) reported that drought stress reduced no. of spikes/m^2 by 10.55%.

No. of grains/spike

The combined average over seasons for no. of grains/spike under normal irrigation condition ranged from 59.55 for MK1-10 to 81.50 for Assiut 224 with an average of 71.90. Eighteen new genotypes highly significantly surpassed G.168 in no. of grains/spike. On other hand, average no. of grains/spike under drought condition, ranged from 51.53 for MK1-10 to 75.18 for Assiut 228 with an average of 65.14. Eleven new genotypes highly significantly surpassed G.168 in no. of grains/spike, (Table 6).

The new genotypes, i.e., Assiut 224, Assiut 406, Assiut 228, Assiut 724, Assiut 726, MK 1-20, MK 2-27, MK 2-29, MK 7-81, MK 7-83 and $F_6$118 surpassed highly significantly the check cultivar G.168 in no. of grains/spike over all seasons and irrigation treatments. These genotypes could be used to improve no. of grains/spike and consequently grain yield in wheat breeding programs, (Table 6).

Table (2): Separate analysis of variance for the studied traits in the two seasons under both environments.

S.O.V	D.F	2011/2012 (Normal irrigation)					2011/2012 (Drought stress)				
		Mean Square					Mean Square				
		Spike length	No. of spikes /plant	No. of grain / spike	1000-grain weight	Grain yield /plant	Spike length	No. of spikes /plant	No. of grain/ spike	1000-grain weight	Grain yield /plant
Reps	3	0.19	0.11	0.76	0.53	2.88	1.05	0.51	1.09	1.94	1.77
Genotypes	31	6.07**	5.73**	132.70**	34.90**	44.92**	8.09**	5.01**	137.01**	29.56**	24.67**
Error	93	0.20	0.35	2.92	0.74	2.42	0.22	0.34	3.07	0.95	0.93
		2012/2013 (Normal irrigation)					2012/2013 (Drought stress)				
Reps	3	0.11	0.66	1.61	0.27	2.96	0.04	0.66	2.68	0.05	2.49
Genotypes	31	6.78**	8.35**	126.52**	36.93**	23.15**	7.41**	5.39**	120.41**	30.97**	17.47**
Error	93	0.13	0.35	1.80	0.32	0.66	0.17	0.30	2.69	0.52	0.85

**, Significant at 0.01% level of probability.

Table (3): Combined analysis of variance for the studied traits over the two seasons and environments.

S. O. V	D.F	Mean Square				
		Spike length	No. of spikes/plant	No. of grain / spike	1000-grains weight	Grain yield /plant
Seasons (S)	1	0.001	264.213**	0.028	0.683	613.309**
Error (a)	6	0.426	0.575	1.271	0.678	1.268
Environments (E)	1	63.563**	275.538**	4283.908**	1832.016**	2580.897**
S x E	1	0.125	3.816**	0.439	14.681**	3.583**
Error b	6	0.267	0.393	1.803	0.715	3.786
Genotypes (G)	31	27.079**	19.459**	469.031**	115.893**	76.905**
G x S	31	0.366*	2.246**	8.504**	1.683**	16.457**
G x E	31	0.798**	2.159**	37.128**	14.057**	12.398**
G x S x E	31	0.113	0.621**	1.975	0.715	4.463**
Error (c)	372	0.18	0.33	2.66	0.63	1.21

*, **, Significant at 0.05% and 0.01% level of probability, respectively.

Table (4): Combined average over seasons of spike length for the evaluated genotypes under normal irrigation and drought stress conditions.

Genotypes	Spike length		
	Normal	Drought stress	Average over all
Assiut 108	11.58	10.48	11.03
Assiut 216	12.60	11.80	12.20
Assiut 217	12.98	12.53	12.76
Assiut 224	15.28	14.73	15.01
Assiut 230	14.08	12.68	13.38
Assiut 238	13.93	13.73	13.83
Assiut 241	13.95	13.60	13.78
Assiut 248	14.45	13.68	14.07
Assiut 249	14.58	14.03	14.31
Assiut 406	13.75	12.68	13.22
Assiut 704	12.13	11.65	11.89
Assiut 228	14.25	13.50	13.88
Assiut 724	15.88	15.58	15.73
Assiut 725	14.38	13.83	14.11
Assiut 726	16.10	14.90	15.50
Assiut 733	14.70	13.38	14.04
Mubarak	11.93	10.73	11.33
MK 1-1	14.35	12.73	13.54
MK 7-15	13.88	13.35	13.62
Assiut 401	12.68	11.00	11.84
Sel 542	15.43	14.85	15.14
MK 1-10	12.30	11.30	11.80
Mk 1-16	13.50	13.25	13.38
Mk 1-20	14.78	14.45	14.62
Mk 2-27	14.65	14.50	14.58
Mk 2-29	15.53	14.30	14.92
Mk 7-81	14.80	14.60	14.70
Mk 7-83	15.33	15.15	15.24
R 80	12.05	11.83	11.94
F6 118	13.55	13.08	13.31
G 168	12.70	12.33	12.51
Sakha 93	12.15	11.45	11.80
Mean	13.88	13.18	13.53
Rev. LSD 0.05	0.50	0.55	0.53
Rev. LSD 0.01	0.66	0.72	0.69
Reduction %	5.04		

Table (5): Average of no. of spikes /plant of evaluated genotypes under normal irrigation and drought stress conditions.

Genotypes	2011/2012		2012/2013		Combined		Average over all
	Normal	Drought	Normal	Drought	Normal	Drought	
Assiut 108	8.55	7.40	8.90	7.05	8.73	7.23	7.98
Assiut 216	9.53	7.50	11.08	7.70	10.30	7.60	8.95
Assiut 217	8.00	7.00	11.10	8.85	9.55	7.93	8.74
Assiut 224	5.50	5.05	8.60	6.85	7.05	5.95	6.50
Assiut 230	7.60	6.55	8.85	7.60	8.23	7.08	7.66
Assiut 238	8.10	7.95	8.85	8.25	8.48	8.10	8.29
Assiut 241	6.88	5.45	7.90	6.75	7.39	6.10	6.75
Assiut 248	6.25	5.60	8.05	7.10	7.15	6.35	6.75
Assiut 249	7.55	7.20	9.25	8.10	8.40	7.65	8.03
Assiut 406	6.75	6.60	9.45	8.70	8.10	7.65	7.88
Assiut 704	6.30	5.95	9.25	8.65	7.78	7.30	7.54
Assiut 228	8.65	7.10	9.80	8.10	9.23	7.60	8.42
Assiut 724	6.23	4.85	6.15	5.00	6.19	4.93	5.56
Assiut 725	7.85	5.85	9.70	8.00	8.78	6.93	7.86
Assiut 726	6.45	5.85	6.60	6.40	6.53	6.13	6.33
Assiut 733	6.80	5.60	9.85	7.55	8.33	6.58	7.46
Mubarak	7.35	5.40	8.50	5.65	7.93	5.53	6.73
MK 1-1	6.50	5.45	9.20	6.25	7.85	5.85	6.85
MK 7-15	9.05	5.55	9.45	7.25	9.25	6.40	7.83
Assiut 401	9.05	7.05	10.40	8.25	9.73	7.65	8.69
Sel 542	6.55	5.05	8.15	5.55	7.35	5.30	6.33
MK 1-10	8.20	5.65	10.20	6.40	9.20	6.03	7.62
Mk 1-16	6.55	4.65	8.60	6.10	7.58	5.38	6.48
Mk 1-20	6.15	4.45	7.55	5.60	6.85	5.03	5.94
Mk 2-27	6.10	4.35	7.15	6.35	6.63	5.35	5.99
Mk 2-29	6.35	5.15	7.20	6.90	6.78	6.03	6.41
Mk 7-81	6.15	4.85	7.15	6.60	6.65	5.73	6.19
Mk 7-83	6.05	4.70	6.35	5.20	6.20	4.95	5.58
R 80	9.80	8.65	12.50	10.00	11.15	9.33	10.24
F6 118	7.70	6.15	9.50	7.75	8.60	6.95	7.78
G 168	6.40	5.90	8.90	7.60	7.65	6.75	7.20
Sakha 93	5.20	4.20	7.45	7.05	6.33	5.63	5.98
Mean	7.19	5.90	8.80	7.16	8.00	6.53	7.26
Mean	6.55		7.98		7.27		
Rev. LSD 0.05	0.77	0.75	0.74	0.68	0.74	0.70	0.72
Rev. LSD 0.01	1.00	0.98	0.96	0.89	0.97	0.92	0.94
Reduction %	17.94		18.64		18.38		

The reduction in no. of grains/spike due to water stress in the first and second season was 9.40% compared to normal irrigation condition. Also, the reduction in no. of grains/spike recorded from 24.4 to 17.1% (Oosterhuis and Cartwright, 1983), 49% (Aggarwal *et al*. 1986), 45% (Blum *et al*. 1990), from 9.17 to 22.50% (Tawfelis, 2006) and from 40.50, 29.02 and 23.28% (Nassar, 2013).

1000-grain weight

The combined average over seasons for 1000- grain weight under normal irrigation condition, ranged from 48.84 for MK7-15 to 57.14 for MK7-83 with an average of 51.84 g. Fourteen genotypes highly significantly surpassed Sakha93 in 1000-grain weight. On other hand, the average 1000- grain weight under drought condition, ranged from 42.76 for Assiut 704 to 50.76 for MK7-83 with an average of 46.06 g. All the tested new genotypes highly significantly surpassed Sakha 93 in 1000-grain weight, (Table 6).

Twenty two new genotypes over all seasons and irrigation treatments highly significantly surpassed the check cultivar Sakha 93 in 1000-grain weight. These genotypes could be used to improve 1000- grain weight and consequently grain yield in wheat breeding programs, (Table 6).

The reduction in 1000- grain weight due to water stress in over the first and second season was 11.15% compared to normal irrigation condition. Also, the reduction in 1000-grain weight recorded 12% (Sayed 1982) from 35.9 to 25.1 g (Bruckner and Frohberg 1987), 17% (Schonfeld *et al*. 1988), 4.24% (Kheiralla *et al.* 1997) and from 6.2, 16.5 and 37.4% (Nassar, 2013). Aggarwal *et al*. (1986) showed that the 1000- grain weight differed among irrigation treatments and it was reduced by water stress. Tawfelis (2006) reported that wheat genotypes differently responded to different environmental conditions.

The results indicated that drought and heat stress reduced number of 1000-grain weight by 9.06% and 22.06%, respectively, compared to normal.

Grain yield/plant:

The combined average over seasons for grain yield/plant under normal irrigation condition ranged from 17.90 for MK1-16 to 28.76 for Assiut 228 with an average of 21.90 g. Twenty two new genotypes highly significantly surpassed G.168. On other hand, the average grain yield/plant under drought condition, ranged from 12.52 for Mubarak to 21.30 for Assiut 228 with an average of 16.41 g. Sixteen new genotypes highly significantly surpassed G.168 in grain yield/plant, (Table 7).

Table (6): Combined average over seasons of no. of grains/spike and 1000-grain weight for the evaluated genotypes under normal irrigation and drought stress conditions.

Genotypes	No. of grains/spike			1000- grain weight		
	Normal	Drought stress	Average over all	Normal	Drought stress	Average over all
Assiut 108	62.68	60.10	61.39	49.18	45.73	47.46
Assiut 216	73.70	67.43	70.57	50.39	45.54	47.97
Assiut 217	66.88	65.50	66.19	50.93	43.80	47.37
Assiut 224	81.50	72.43	76.97	52.56	44.15	48.36
Assiut 230	70.33	61.60	65.97	50.91	43.45	47.18
Assiut 238	74.43	66.23	70.33	52.56	45.60	49.08
Assiut 241	65.60	64.03	64.82	55.38	49.36	52.37
Assiut 248	74.60	60.75	67.68	53.98	45.58	49.78
Assiut 249	67.53	64.85	66.19	51.78	44.86	48.32
Assiut 406	75.20	72.63	73.92	49.08	42.93	46.01
Assiut 704	70.73	62.10	66.42	49.29	42.76	46.03
Assiut 228	79.93	75.18	77.56	50.38	46.35	48.37
Assiut 724	76.85	73.38	75.12	56.98	48.74	52.86
Assiut 725	73.20	64.38	68.79	51.64	48.26	49.95
Assiut 726	73.65	67.80	70.73	54.19	47.30	50.75
Assiut 733	72.48	64.35	68.42	53.76	45.51	49.64
Mubarak	63.05	56.98	60.02	50.70	46.74	48.72
MK 1-1	70.70	59.13	64.92	51.81	47.55	49.68
MK 7-15	70.98	61.38	66.18	48.84	44.68	46.76
Assiut 401	73.28	62.63	67.96	54.30	49.11	51.71
Sel 542	69.78	63.60	66.69	54.00	50.55	52.28
MK 1-10	59.55	51.53	55.54	50.30	45.63	47.97
Mk 1-16	65.70	59.28	62.49	55.36	48.69	52.03
Mk 1-20	76.18	68.00	72.09	55.34	47.54	51.44
Mk 2-27	75.83	71.78	73.81	52.91	46.44	49.68
Mk 2-29	81.35	72.85	77.10	51.75	48.53	50.14
Mk 7-81	75.70	70.45	73.08	49.16	45.78	47.47
Mk 7-83	76.33	67.85	72.09	57.14	50.76	53.95
R 80	72.75	61.95	67.35	52.38	47.61	50.00
F6 118	79.43	71.83	75.63	49.19	45.35	47.27
G 168	68.93	64.68	66.80	41.74	37.85	39.80
Sakha 93	61.95	57.00	59.48	51.18	41.28	46.23
Mean	71.90	65.14	68.52	51.84	46.06	48.95
Rev. LSD 0.05	1.92	2.12	2.03	0.91	1.07	1.00
Rev. LSD 0.01	2.51	2.77	2.64	1.19	1.40	1.30
Reduction %	9.40			11.15		

Table (7): Average of grain yield/plant of evaluated genotypes under normal irrigation and drought stress conditions.

Genotypes	2011/2012		2012/2013		Combined		Average over all
	Normal	Drought	Normal	Drought	Normal	Drought	
Assiut 108	19.31	16.59	22.94	15.03	21.12	15.81	18.47
Assiut 216	26.22	19.56	26.33	19.64	26.28	19.60	22.94
Assiut 217	20.57	15.30	23.93	20.58	22.25	17.94	20.10
Assiut 224	17.13	14.24	21.77	18.86	19.45	16.55	18.00
Assiut 230	18.86	16.46	22.12	14.85	20.49	15.65	18.07
Assiut 238	26.95	19.37	24.14	18.97	25.54	19.17	22.36
Assiut 241	17.84	13.61	20.21	16.29	19.02	14.95	16.99
Assiut 248	20.91	17.09	21.95	18.32	21.43	17.71	19.57
Assiut 249	22.14	18.93	23.46	19.53	22.80	19.23	21.02
Assiut 406	19.86	15.53	23.18	19.01	21.52	17.27	19.40
Assiut 704	17.20	15.47	23.15	17.94	20.18	16.71	18.45
Assiut 228	28.73	21.21	28.78	21.40	28.76	21.30	25.03
Assiut 724	19.95	14.74	21.67	15.70	20.81	15.22	18.02
Assiut 725	22.69	14.59	23.89	17.56	23.29	16.07	19.68
Assiut 726	22.25	15.80	22.53	15.98	22.39	15.89	19.14
Assiut 733	23.84	14.71	28.46	18.59	26.15	16.65	21.40
Mubarak	19.04	10.74	23.78	14.31	21.41	12.52	16.97
MK 1-1	17.17	13.01	20.26	15.85	18.72	14.43	16.58
MK 7-15	23.41	15.53	23.16	17.79	23.29	16.66	19.98
Assiut 401	25.35	17.10	24.04	17.66	24.69	17.38	21.04
Sel 542	21.53	15.41	25.96	14.94	23.74	15.18	19.46
MK 1-10	21.75	15.75	23.01	14.90	22.38	15.33	18.86
Mk 1-16	17.47	12.69	18.33	13.15	17.90	12.92	15.41
Mk 1-20	19.94	13.40	20.56	14.55	20.25	13.97	17.11
Mk 2-27	16.75	13.69	20.48	18.44	18.61	16.06	17.34
Mk 2-29	22.89	17.60	22.67	19.15	22.78	18.37	20.58
Mk 7-81	19.56	15.16	23.53	17.97	21.54	16.56	19.05
Mk 7-83	21.18	14.21	20.36	16.16	20.77	15.18	17.98
R 80	22.48	17.92	27.51	19.88	24.99	18.90	21.95
F6 118	21.01	15.96	24.18	19.91	22.59	17.93	20.26
G 168	15.16	10.85	21.95	18.50	18.55	14.68	16.61
Sakha 93	14.14	10.73	20.43	16.22	17.28	13.47	15.38
Mean	20.73	15.40	23.08	17.43	21.90	16.41	19.16
Mean	18.07		20.26		19.16		
Rev. LSD 0.05	1.95	1.21	1.01	1.15	1.55	1.18	1.38
Rev. LSD 0.01	2.54	1.58	1.32	1.50	2.02	1.54	1.80
Reduction %	25.71		24.48		25.07		

Twenty five new genotypes over all seasons and irrigation treatments highly significantly surpassed the check cultivar Sakha 93 in grain yield/plant. The results showed that the new tested genotypes, i.e., Assiut 216, Assiut 238, Assiut 228, Assiut 726, Assiut 401 and R 80 gave highly significantly grain yield compared to the two checks over all seasons and irrigation treatments. These genotypes could be used to improve grain yield/plant and consequently grain yield in wheat breeding programs, (Table 7).

The reduction in grain yield/plant due to water stress in the two seasons was 25.07% compared to normal irrigation condition. Also, the reduction in grain yield/plant recorded 60% (Pal *et al*. 1979), 30% (Schonfeld *et al*. 1988), 12.7% (Kheiralla *et al*. 1989), 29.1% (Abo-Shetaia and Abd El-Gawad, 1995), 39.4% (Kheiralla *et al.* 1997), 29.80% (Kheiralla *et al.* 2004), from 27.37 to 23.1 (Mostafa *et al.* 2012). Ghanem *et al*. (1990) found that five irrigations significantly increased grain yield by 20% over three irrigations and by 17.25% over four irrigations, respectively.

B- Drought susceptibility index:

In 2011/2012 season, drought susceptibility index (DSI) ranged from 0.39 for Assiut 704 to 1.70 for Mubarak with an average of 0.99±0.05. The new genotypes, Assiut 108, Assiut 224, Assiut 230, Assiut 249 and Assiut 704 showed DSI less than 0.67, so these genotypes were considered to be highly tolerant to drought. Moreover the genotypes, Assiut 216, Assiut 241, Assiut 248, Assiut 406, MK 1-1, MK 2-27, MK 2-29, MK 7-81, R 80 and $F_6$118 showed DSI less than one, so these genotypes were considered to be tolerant to drought stress, (Table 8).

In 2012/2013 season, drought susceptibility index (DSI) ranged from 0.41 for MK 2-27 to 1.73 for Sel. 542 with an average of 0.99±0.06. The new genotypes, Assiut 217, Assiut 224, Assiut 248, Assiut 249, MK 2-27 and MK 2-29 showed DSI less than 0.69, so these genotypes were considered to be highly tolerant to drought. The genotypes, Assiut 238, Assiut 241, Assiut 406, Assiut 704, MK 1-1, MK 7-15, MK 7-81, MK 7-83, and $F_6$118 showed DSI less than one, and more than 0.69 so these genotypes were considered to be tolerant to drought stress, (Table 8).

In general, the less the difference between grain yield under both environments the less the value of DSI the high degree of tolerance. Drought susceptibility index varied greatly from year to year with inconsistent direction. However, the new genotypes, Assiut224, Assiut248, Assiut 249, Assiut 406, Assiut 704 and MK 2-27 were considered to be tolerant to water stress and could be used in wheat breading programs, especially Assiut224 and Assiut249.

Table (8): Drought susceptibility index for grain yield/plant in the two seasons.

Genotypes	2011/2012			2012/2013		
	Normal	Drought	DSI	Normal	Drought	DSI
Assiut 108	19.31	16.59	0.55	22.94	15.03	1.41
Assiut 216	26.22	19.56	0.99	26.33	19.64	1.04
Assiut 217	20.57	15.30	1.00	23.93	20.58	0.57
Assiut 224	17.13	14.24	0.66	21.77	18.86	0.55
Assiut 230	18.86	16.46	0.49	22.12	14.85	1.34
Assiut 238	26.95	19.37	1.09	24.14	18.97	0.87
Assiut 241	17.84	13.61	0.92	20.21	16.29	0.79
Assiut 248	20.91	17.09	0.71	21.95	18.32	0.68
Assiut 249	22.14	18.93	0.56	23.46	19.53	0.68
Assiut 406	19.86	15.53	0.85	23.18	19.01	0.73
Assiut 704	17.20	15.47	0.39	23.15	17.94	0.92
Assiut 228	28.73	21.21	1.02	28.78	21.40	1.05
Assiut 724	19.95	14.74	1.02	21.67	15.70	1.13
Assiut 725	22.69	14.59	1.39	23.89	17.56	1.08
Assiut 726	22.25	15.80	1.13	22.53	15.98	1.19
Assiut 733	23.84	14.71	1.49	28.46	18.59	1.42
Mubarak	19.04	10.74	1.70	23.78	14.31	1.63
MK 1-1	17.17	13.01	0.94	20.26	15.85	0.89
MK 7-15	23.41	15.53	1.31	23.16	17.79	0.95
Assiut 401	25.35	17.10	1.27	24.04	17.66	1.08
Sel 542	21.53	15.41	1.11	25.96	14.94	1.73
MK 1-10	21.75	15.75	1.07	23.01	14.90	1.44
Mk 1-16	17.47	12.69	1.06	18.33	13.15	1.15
Mk 1-20	19.94	13.40	1.28	20.56	14.55	1.19
Mk 2-27	16.75	13.69	0.71	20.48	18.44	0.41
Mk 2-29	22.89	17.60	0.90	22.67	19.15	0.63
Mk 7-81	19.56	15.16	0.87	23.53	17.97	0.97
Mk 7-83	21.18	14.21	1.28	20.36	16.16	0.84
R 80	22.48	17.92	0.79	27.51	19.88	1.13
F6 118	21.01	15.96	0.93	24.18	19.91	0.72
G 168	15.16	10.85	1.11	21.95	18.50	0.64
Sakha 93	14.14	10.73	0.94	20.43	16.22	0.84
Average ±S.E	-		0.99±0.05	-		0.99±0.06

The results obtained by Ehdaie *et al*. (1988) reported that the wide range of stress susceptibility index (S) and yield were not associated, indicating that they may be independent components which contribute to adaptation to stress environments. Guttieri *et al*. (2001) reported that the overall moisture-deficit-induced reduction in yield was due primarily to reduction in grain weight. Effects of moisture deficit on yield of specific cultivars were due largely to its effects on number of grains/spike. Drought sensitivity indices (DSIs) for yield were correlated to cultivar yield potential. El-Morshidy *et al*. (2010) cleared that nine families have high grain yield under drought stress conditions due to high yield potential, rather than having low susceptibility to stress environments. These families could be used also as source of drought tolerance.

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تقييم بعض التراكيب الوراثية الجديدة فى قمح الخبز لمحصول الحبوب ومكوناته تحت ظروف الإجهاد المائي

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الملخص:

أجري هذا البحث في مزرعة كلية الزراعة بجامعة أسيوط موسمى ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ بهدف تقييم ٣٠ تركيب وراثى من قمح الخبز وصنفى كنترول هما: Giza 168 ، Sakha 93 تحت ظروف الري العادى والإجهاد المائى (رية الزراعة ورية المحاياه فقط). أظهر التحليل الفردى اختلافات معنوية جدا بين التراكيب الوراثية لكل الصفات تحت الدراسة. اظهر تحليل التباين المشترك للمواسم ومعاملات الرى اختلافات معنوية جداً بين المواسم لصفتى عدد السنابل/نبات ومحصول الحبوب للنبات. كذلك أشار التباين الذى يرجع إلى البيئات والتراكيب الوراثية ، التفاعل بين التراكيب الوراثية والمواسم والتفاعل بين التراكيب الوراثية والبيئات معنوى جدا لكل الصفات تحت الدراسة. كان التفاعل الثلاثي معنوى جدا لكل من عدد السنابل/نبات ومحصول الحبوب للنبات. أدى تأثير الجفاف إلى انخفاض طول السنبلة، عدد السنابل/ نبات، عدد الحبوب/سنبلة، وزن ١٠٠٠ حبة ومحصول الحبوب/نبات بمقدار ٥,٠٤، ١٨,٣٨، ٩,٤٠، ١١,١٥ و ٢٥,٠٧٪على التوالي مقارنة بالرى العادى. وكان من الواضح أن التراكيب الوراثية الجديدة أسيوط ٢١٦ وأسيوط ٢٣٨، أسيوط ٢٢٨، أسيوط ٧٢٦ و R 80كانت متفوقة فى محصول الحبوب للنبات إلى جانب صفه أو أكثر من الصفات تحت الدراسة عن صنفى الكنترول. كما أشار معامل الحساسية للجفاف إلى قدرة تحمل التراكيب الوراثية الجديدة أسيوط ٢٢٤ وأسيوط ٢٤٨ وأسيوط ٢٤٩ وأسيوط ٤٠٦ وأسيوط ٧٠٤ وMK2-27 لظروف الجفاف. وعلى ذلك يمكن استخدام تلك التراكيب الوراثية الجديدة في برامج لتحسين محصول الحبوب والمقاومة للجفاف فى محصول القمح.