International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.9, No.05 pp 89-99, 2016

Evaluation of new bread wheat lines *(Triticum aestivum* L) under normal and water stress conditions

R.M. Esmail, Sara E.I. Eldessouky*, Sherin A. Mahfouze and I.S. EL-Demardash

Genetics and Cytology Dept., National Research Centre, Dokki, Cairo, Egypt.

Abstract: The investigation was carried out to evaluate some new bread wheat genotypes under normal and water deficit conditions. 25F6 bread wheat genotypes and one check variety (Sakha93) were grown at three different locations (1-Shebin El-kom, Menofiya; 2-Alkanater, Kalubia; and 3- Nubaria, Beheira, Egypt). Many agronomic traits were studied such as days to heading, flag leaf area (cm2), plant height (cm), number of spikes/plant, spike length (cm), 100 kernel weight (gm), grain yield/plant (gm), harvest index and biological yield/plant. The results revealed highly significant differences among the genotypes for all characters indicating the presence of considerable variability among them. Genotypes 10,11,12,13 and 24 were early flowering at all locations under normal and water stress conditions. Genotypes 7,2,1,9 and 3 gave the highest performance for no. of spikes/plant. The best selected genotypes for grain yield were 5, 12, 18, 20, 21 and 22 which exhibited high grain yield under spray irrigation at Nubaria.
Key words: Irrigation regime, drought tolerance, *Triticum aestivum L,* genetic diversity, new wheat lines.

Introduction

Wheat is one of the most important nutritional agricultural crops of the business world, accounting for 30% of grain production in the world[1]. Egypt is one of the five largest importers of wheat in the world (about 7 million tons per year). In recent years, world prices for wheat raised to 4-folds due to exposure to adverse climatic conditions and the use of wheat in the production of biofuels (ethanol).

According to the UN Food and Agriculture Organization (FAO), farmers need to double food production by 2050. At past years, crop yields declined because of climate changes and other things. Drought stress is one of the most widespread environmental stresses, which affect growing and productivity; it induces many physiological, biochemical and molecular responses on plants. So that plants became able to develop tolerance mechanisms which will be provided adaptation to adverse environmental conditions[2,3,4].

Due to the limited water resources and the occurrence of Egypt under the water poverty line (1000 cubic meters per person per year), any expected increase in cultivated land and consequently agricultural production in Egypt is attributed to improve water use efficiency for agricultural purposes, and vertical expansion by increasing the unit area productivity. Future climate changes are expected to increase risks of drought and breeding crops for drought tolerance is therefore required for both mild and severe stress conditions. This implies a need for a better characterization of the biodiversity available for drought and a deeper comprehension of the physiological mechanisms, which are crucial to assure yield when drought occurs[5,6,7,8].

To meet these objectives, a wide range of germplasm must exist. Wheat breeding materials must be evaluated under a wide array of environmental and management practices to characterize performance and adaptation.

Therefore, breeding programs must focus to solve this problem. The plant breeder has the responsibility to develop and identify cultivars that will enhance commercial production of a crop. All plant breeding programs have the same ultimate objective to improve yield and quality characteristics in order to produce varieties attractive to farmers or other end users, Another breeding goal is resistance to biotic and abiotic stresses, i.e. pests and disease; heat, cold, drought and extremes of soil types. Improving the genetic potential of wheat to drought stress and identification of tolerant genotypes are the main objectives of regional breeding programmes[9,10].

The goal of this study were field-evaluation of 25 F6 wheat selected lines under normal (L1) and water stress (L2) conditions at three locations to identify high-yielding genotypes and drought tolerant F6 lines for use in pure line variety development efforts.

Materials and Methods

The plant materials used in this investigation included 25 F6 bread wheat lines and one check variety (Sahka 93).These lines derived from three way crosses between Egyptian wheat cultivars with CYMMIT and ICARDA germplasm lines. These materials were evaluated in three different regions (1-Shebin EL-Kom, Menofiya-2-Al-Kanater Alkhireia, Kalubia and 3- Nubaria, Behira Governorate, Egypt) under different irrigation regimes.

The first one was normal irrigation (L1), five irrigation through the whole season, the second one was water stress (L2), two irrigations through the whole season and the third one was spray irrigation (irrigating every four days) at Nubaria. The number and dates of irrigations in the two locations are presented in Table (1). Grains were grown in November, 30 in Nubaria.

Table (1): Numbers and dates of irrigations for 26 wheat genotypes in 2010/2011 season at Shebin El-Kom and Al-Kanater regions.

<table>
<tr><th>Normal irrigation regime (L1)
(Shebin El-Kom).</th><th>Water stress conditions (L2)
(Shebin El-Kom).</th></tr>
<tr><td>First- November, 21(sowing irrigation)</td><td rowspan="3">First- November, 21
(sowing irrigation)</td></tr>
<tr><td>Second- December, 7</td></tr>
<tr><td>Third- January, 8*</td></tr>
<tr><td>Fourth- February, 13</td><td rowspan="2">Second- December, 7</td></tr>
<tr><td>Fifth - March, 2**</td></tr>
<tr><th>Normal irrigation regime (L1)
(Al-Kanater)</th><th>Water stress conditions (L2)
(Al-Kanater)</th></tr>
<tr><td>First- December, 20(sowing irrigation)</td><td rowspan="3">First- December, 20
(sowing irrigation)</td></tr>
<tr><td>Second - January, 21</td></tr>
<tr><td>Third - February, 23</td></tr>
<tr><td>Fourth - March, 24</td><td>Second - January, 21</td></tr>
</table>

*Rains fall in January, 14, ** rains fall in April, 3 and 7.

All experiments lay out in a randomized complete block design with three replications for five separate field trials (two in Shebin EL-Kom, two in Al-Kanater and one in Nubaria). The experiments were conducted during 2010/ 2011 growing season. Each progeny lines were grown in three rows, three meters long. The spacing between and within rows were maintained at 30 and 10 cm, respectively. All the normal agronomic practices were followed as usual in the ordinary wheat field in the areas of study.

The normal irrigated plants were watered at planting, tillering, jointing, flowering and grain filling stages. All five field trials in the three experimental locations got water irrigation other than rainfall.

The studied characters were days to heading, flag leaf area (cm^2), plant height (cm), number of spikes/plant, spike length (cm), 100-kernel weight (gm) , grain yield/plant (gm), harvest index and biological yield / plant.

Drought susceptibility index (DSI) was calculated for grain yield / plant to characterize relative drought tolerance of all genotypes, using a generalized formula [DSI = (1-Yd/Yw)/ (1- Xd / Xa)][11], Where: Yd is the yield of an individual genotype under dry conditions (L2) and Ya is the yield of the same genotype in the normal irrigation conditions (L1) and Xd and Xa are the average yield of all the twenty six genotypes evaluated under dry and normal irrigations conditions, respectively. Also, stress tolerance index (STI) was computed according to[12].

$$DTI = \frac{\text{Grain yield under stress conditions}}{\text{Grain yield under normal conditions}} \times 100$$

The statistical analysis of data was conducted according to[13]. The means of all genotypes were compared using the Least Significant Difference (LSD) method at 5% of probability. Prepare of these statistical calculations was conducted for each experiment using SPSS[14] 10 for windows.

Results and Discussion

The analysis of variance of all studied traits is presented in Tables (2, 3 and 4). Highly significant genotype differences were recorded for all characters indicating the presence of considerable variability among the tested new wheat lines. Also, these variations among genotypes might partially reflect their different genetic backgrounds. [15,16,17,18,19,20,21,22,23] found significant variation in yield and yield components among wheat genotypes under favorable and unfavorable conditions

Table (2): Mean square values for all studied characters among the twenty six bread wheat genotypes under normal (L1) and water stress conditions (L2) at Shebin El-Kom.

S.O.V	D.F	Days to heading	Plant height (cm)	Spike no.	Spike length (cm)	Grain yield /Plant	Harvest index	Biological yield (g)	100 Grain weight (g)
Normal irrigation (L1)									
Reps	2	0.0897	1.82	0.475	0.044	1.46	2.028	17.6	0.038
Lines	25	84.83**	1108.06**	8.873**	4.793**	111.68**	46.952**	954.69**	1.301**
error	50	0.663	2.71	0.73	0.123	2.8	5.424	3.08	0.0329
Water stress (L2)									
Reps	2	0.269	3.376	1.478	0.102	5.948	8.21	19.52	0.0028
Lines	25	88.45**	976.19**	8.368**	5.143**	128.529**	27.94**	1156.64**	1.067**
Error	50	1.14	1.495	0.538	0.241	10.37	10.66	34.96	0.0038

Table (3): Mean square values for all studied characters among the twenty six bread wheat genotypes evaluated under normal (L1) and stress conditions (L2) at (Al-Kanater).

S.O.V	D.F	Days to heading	Plant height (cm)	Spike no.	Spike length (cm)	Grain yield /Plant	100 Grain weight
Normal irrigation (L1)							
Reps	2	0.474	1.26	8.03	0.275	3.54	0.005
Lines	25	69.49**	1162.49**	23.94**	5.22**	170.29**	0.889**
Error	50	1.05	2.73	1.231	0.1	5.68	0.008
Water stress (L2)							
Reps	2	0.089	2.94	1.15	1.29	22.49	0.022
Lines	25	60.85**	1052.82**	11.09**	5.584**	104.83**	0.884**
Error	50	0.92	3.76	0.314	0.167	8.33	0.0124

Table (4): Mean square values for all studied characters among the twenty six bread wheat genotypes at Nubaria.

S.O.V	D.F	Days to heading	Plant height (cm)	Spike no./plant	Spike length (cm)	Grain yield /Plant	100 Grain weight (g)	Harvest index	Biological yield (g)	Flag leaf area (cm^2)
Reps	2	14.86	7.29	0.77	1.13	0.616	0.022	0.261	3.86	0.371
Lines	25	94.27**	670.56**	5.06**	8.46**	37.87**	0.839**	82.02**	203.49**	75.06**
Error	50	2.41	1.052	0.349	0.209	0.447	0.0167	1.29	3.08	1.08

The genotypes mean performance for all studied traits are presented in Tables (5, 6 and 7). Generally, results overall locations revealed that the rank of genotypes (per se) relative to its mean performance was differed from one irrigation regime to another indicated that the studied genotypes responded differently to the environmental conditions which suggesting the importance of our tested genotypes under different environments in order to identify the best genetic make up for a particular environment. Genotypes 10-13 and 24 exhibited a more early flowering lines at all location under normal and water stress conditions. With respect to plant height, results revealed that maximum culm lengths were attained by genotype 5 (150.1cm) and 11 of (145.5 cm), whereas minimum plant heights given by genotypes19 (82.58 cm) and 20 (54.33 cm). [24,25]observed substantial decline in plant height when irrigation was withheld at booting stage, however tolerant genotypes attained more plant height.

In Shebin EL-Kom (Table 5), number of spikes/plant, 100-kernel weight, grain yield/plant, harvest index and biological yield were increased in water stress condition relative to overall mean performance (average). Spike length was decreased under water stress condition (Table 5).Concerning no. of spikes / plant, means ranged from (5.62 to 12.02) and from (5.17 to12.76) spikes/ plant under normal and water stress conditions, respectively. This is suggested possessing a potentiality for obtaining more improvement cultivars. Lines 7, 2, 1, 9 and 3 had the highest spikes / plant. Results showed that the genotypes 1,3,7,11,17 and 9 had the highest values of grain yield comparing to check variety (Sakha-93) under normal conditions (L1). Moreover, these lines had the highest values of biological yield and harvest index. On the other hand, genotypes 1, 5, 13, 23 and 9 gave the highest values of grain yield/ plant under water stress conditions (L2). On the average, genotypes 1, 3, 5, 9,13,15,16,17,18,21 and 23 gave the highest grain yield/plant under both normal and water stress conditions.

Evaluation of the pre-breeding materials includes yield trials, screening for host-plant resistance to biotic and a biotic stresses, and testing for general agronomic merit and adaptation, must occur under controlled environment, where drought will be reliably induced to distinguish between tolerant and susceptible genotypes.

Over all, drought stress reduced significantly the yield of some genotypes and some of them revealed tolerance to drought, which suggested the genetic variability for drought tolerance in these materials. The different crop developmental stages show different sensitivity to drought stress.

Table (5): Mean performance under normal (L1) and water stress (L2) conditions, drought susceptibility index (DSI) and stress tolerance index (STI) for all studied characters of 26 bread wheat genotypes at Shebin El-Kom.

Genotype	Days to heading L1------ ----L2		Plant height.(cm) L1------ -----L2		Spike no./plant L1 ---- -----L2		Spike length (cm) L1-------- ---L2		Grain yield /plant (g) L1------ -----L2		100 Grain weight (g) L1------ -----L2		Harvest index. L1------ -----L2		Biological yield /plant (g) L1------ -----L2		(D.S.I)	(S.T.I)
1	101	99.33	126.67	127.29	11.45	10.97	12.61	12.26	35.86	39.27	4.73	4.74	32.67	33.32	109.67	119.44	1.046	2.85
2	84.33	84	103	97	11.8	7.47	14	11.94	21.4	19.17	3.86	3.59	32.24	42.48	66.33	48.75	-1.15	0.831
3	102	101	127.07	123.53	10.07	9.79	12.7	10.33	35.31	26.09	4.19	4.06	39.02	37.79	86.82	69.33	-2.87	1.866
4	97	97	114.67	112.61	8.99	8.1	12.17	13.16	21.7	27.49	4.29	5.11	28.36	35.25	75	78.33	2.935	1.208
5	87.33	81	149.53	149.11	8.08	10.18	11.67	11.67	18.98	36.64	5.02	5.50	21.42	37.74	89.67	102	10.246	1.41
6	88	84	123.94	102.18	8.5	10.62	9.9	12.64	18.06	2.05	3.85	4.33	29.91	32.53	60.42	72	2.43	0.806
7	88.3	86.33	116.67	120.33	12.02	10.42	13.56	13.74	30.74	29.35	4.66	5.24	34.27	33.19	89.73	93.68	-0.4974	1.83
8	89.33	82	120	104.33	9.67	10.09	10.83	10.94	24.64	20.36	4.24	4.24	32.85	37.16	75	53.33	-1.91071	1.016
9	90	83.67	113.67	108.15	11.07	12.96	12.28	12	25.35	31.11	4.35	5.15	35.22	39.23	72	79.33	2.4994	1.59
10	83.33	82.66	97.77	94.49	8.7	10.23	13.44	12.83	13.32	21.52	2.98	3.8	31.75	32.35	42	60.33	6.7717	0.58
11	95.33	88.67	150	150	9.07	8.43	13	11.77	30.53	25.24	4.81	5.04	29.55	32.89	103.33	77	-1.9059	1.56
12	91.67	86	90.77	104.4	8.32	9.56	12.96	13	22.68	22.92	5.05	4.19	37.52	36.79	59.62	59.03	0.1164	1.05
13	84	85.33	138	121.24	6.47	9.04	13.64	12.58	18.16	32.85	5.61	5.84	34.49	38.12	62.33	79.67	8.898	1.21
14	92.33	88.67	117.87	116.59	7.89	8.56	11.8	11.84	24.23	24.62	4.62	4.45	34.49	38.67	70.99	61	0.17705	1.21
15	87.67	86.67	111.21	114.24	8.36	10.03	12.32	12.52	20.57	30.22	5.02	5.36	35.96	38.61	59.8	76	5.1604	1.26
16	88.67	86	98.71	95.74	9.1	8.62	13.4	12.73	21.74	17.83	5.09	4.64	38.23	39.54	56.63	47	-1.9784	0.78
17	87.67	86.67	109.27	113.04	9.25	9.77	12.93	12.23	25.37	25.81	4.81	5.16	36.19	36.69	70.11	66.67	0.190776	1.33
18	86.63	88.33	90.76	90.7	6.88	8.53	13.04	13.33	19.32	20.02	5.04	4.37	32.35	38.27	59.74	65	0.3985	0.78
19	89	88.67	83.1	82.58	6.55	5.7	11.09	11.71	18	14.18	5.59	5.27	36.14	39.63	49.89	39.3	-2.33	0.57
20	92.67	90	66.8	65.98	8.13	8.49	10.59	12.4	11.52	16.71	5.11	4.77	27.69	36.08	40.63	40.67	4.9557	0.389
21	92.33	88.67	103.47	102	8.01	9.39	10.68	11.83	24.02	29.79	4.55	4.94	38.92	40.16	62.73	70.67	2.642	1.45
22	89.67	89	104.73	98.63	9.84	10.33	10.67	10.75	23.69	25.69	3.54	4.56	36.83	43.07	64.33	62.33	0.9287	1.23
23	102	96	125.26	118.08	8.61	9.92	11.13	10.96	24.38	32.01	4.15	4.44	32.06	37.07	76	87.33	3.4425	1.58
24	84	80	110.67	110.73	5.87	7.04	9.57	9.93	14.39	21.96	5.92	5.74	34.29	34.61	42	59.67	5.786	0.64
25	86.33	81.66	129.23	115.43	5.62	7	12.5	7.5	15.43	24.5	4.77	5.65	31.47	38.09	49.07	61	6.466	0.76
Sakha93	88.67	86.67	99.67	98.33	7	5.17	13.83	10.33	18.29	12.85	5.09	5.16	34.22	34.52	52.33	31.66	-3.2717	0.48
Total	**2349.26**	**2278**	**2922.51**	**2836.73**	**225.32**	**236.41**	**316.31**	**306.92**	**577.68**	**630.25**	**120.9**	**124.54**	**868.11**	**963.85**	**1746.17**	**1760.52**	**---**	**----**
Average	**90.36**	**87.62**	**112.4**	**109.11**	**8.67**	**9.09**	**12.16**	**11.8**	**22.22**	**24.24**	**4.65**	**4.79**	**33.39**	**37.07**	**67.16**	**67.71**	**-----**	**------**
L.S.D	**1.34**	**1.75**	**2.69**	**2.01**	**1.4**	**1.2**	**0.58**	**0.81**	**2.74**	**5.28**	**0.297**	**0.102**	**3.82**	**5.35**	**2.88**	**9.69**	**------**	**-----**

Table (6): Mean performance under normal (L1) and water stress (L2) conditions, drought susceptibility index (DSI) and stress tolerance index (STI) for all studied characters of 26 bread wheat genotypes at Al-Kanater.

Genotype	Days to heading L1------	----L2	Plant height (cm). L1------	-----L2	Spike no./plant L1 ----	-----L2	Spike length (cm) L1--------	---L2	Grain yield /plant (g) L1------	-----L2	100 Grain weight (g)L1------	- ---L2	D.S.I	S.T.I
1	89.33	86	117.67	116.27	19.67	11.82	12.8	11.59	33.52	23.62	4.97	3.65	6.221	1.55
2	80.67	77	97.93	92.33	10.54	10.23	14.71	14.57	19.94	18.58	4.56	3.85	1.44	0.728
3	88	87	116	109.07	13.69	10.8	13.2	12.83	20.01	22.08	4.65	4.32	-2.179	0.869
4	83	84	112.67	103.53	14.6	7.09	14.7	12.7	29.71	15.98	5.92	5.05	9.73	0.934
5	73.33	73.66	148.66	146	7.26	7.27	14	14.06	15.3	17.74	5.64	5.11	-3.36	0.534
6	82.33	82	93.42	92.73	9.23	8.6	11.21	10.87	14.22	13.71	4.43	4.77	0.755	0.3835
7	76.37	76.67	114.07	108.67	12.13	10.53	14.63	15.4	25.94	26.79	5.53	5.13	-0.69	1.367
8	78	80.33	92.86	92.89	9.47	11.03	11.26	12.61	13.72	22.39	4.57	4.64	-13.31	0.604
9	77.67	78.3	107.33	104.73	13.64	11.93	13.38	13.25	32.87	27.18	5.08	5.15	3.64	1.757
10	76.67	76.67	94.73	94.2	11.5	8.5	14.84	13.4	24.38	17.72	4.25	3.61	5.75	0.849
11	78	82.67	149.53	145.67	14.5	11.05	14.16	11.5	8.18	22.01	5.72	5.23	-35.62	0.354
12	75.36	79	97.64	96.33	11.61	8.67	13.35	11.67	21.88	23.27	5.11	4.73	-1.338	1.001
13	72.63	78	105.46	115.73	10.35	9.1	14.29	14.2	19.02	30.03	6.33	5.61	-12.19	1.12
14	76	78	103.86	99.76	9.12	8.8	13.48	12.33	16.76	21.03	5.07	4.66	-5.37	0.69
15	79.33	82.67	108.53	109.27	9.45	14.8	14.43	12.59	25.89	38.7	5.43	4.67	-10.42	1.971
16	78.33	78.33	97.27	102.76	11.21	8.78	14.67	14.29	30.03	26.96	6.03	5.13	2.15	1.593
17	76.67	76.07	102.27	105.33	12.73	10.67	13.41	11.67	32	23.76	5.65	4.7	5.42	1.496
18	80.67	82.67	93.47	87.8	13.4	9.87	13.5	14.17	38.03	30.48	5.76	4.71	4.182	2.28
19	85	84.66	67.5	70.6	8.27	8.57	11.64	11.3	12.4	18.37	5.37	5.04	-10.14	0.448
20	86	85	64	62	10.5	9.42	12.94	11.5	27.28	20.36	5.55	4.36	5.34	1.093
21	83	87.33	85.53	89.33	9.52	8.15	12.31	11.29	22.3	18.27	4.94	4.08	3.806	0.8015
22	79	85	86.25	90.13	9.49	9.87	11.88	11.43	15.19	17.13	4.79	4.10	-2.69	0.5119
23	90.67	90.67	123	117.4	12	8.89	10.39	11.29	18.05	17.56	4.85	4.79	0.5718	0.6235
24	76.67	76	79.33	107.73	6.63	5.74	10.61	10.16	20.49	13.35	5.8	5.7	7.34	0.538
25	80.67	78.66	119.22	116.34	7.91	7.79	13.31	12.23	20.53	15.45	4.69	5.05	5.21	0.624
Sakha 93	72.67	73.66	85.26	85.33	14	6.5	13.33	13.1	28.55	15.61	5.16	5.14	9.55	0.876
Total	**2076.04**	**2100.02**	**2693.81**	**2662.56**	**292.42**	**244.47**	**342.43**	**326**	**586.19**	**558.13**	**135.98**	**122.98**	**-----**	**-----**
Average	**79.85**	**80.77**	**103.61**	**102.41**	**11.25**	**9.40**	**13.17**	**12.54**	**22.55**	**21.46**	**5.23**	**4.73**	**-----**	**----**
L.S.D	**1.68**	**1.57**	**2.71**	**3.18**	**1.82**	**0.93**	**0.52**	**0.67**	**3.91**	**4.73**	**0.101**	**0.182**	**-----**	**----**

Table (7): Mean performance for all studied characters among the twenty six bread wheat genotypes evaluated at Nubaria.

Genotype	Day to heading	Flag leaf area(cm^2)	Plant height(cm)	Spike no./plant	Spike length(cm)	100 grain weight(g)	Grain yield /plant(g)	Harvest index.	Biological yield /plant(g)
1	94	36.21	92.33	7.07	8.5	4.45	8.05	21.4	36.71
2	82.67	34.86	81	4.44	11.17	3.38	5.74	31.04	18.5
3	98	32.03	93	5.7	12.3	3.94	12.2	31.6	38.49
4	92	33.27	101	4.37	10.83	3.85	12.17	28.8	42.23
5	84.33	27.51	118	9.91	10.67	4.34	15.35	35.76	42.9
6	84.61	23.27	88	4.58	11.3	4.33	10.34	38.2	27.11
7	82	30.68	95	5.06	13.3	4.43	8.76	21.7	40.41
8	84.81	28.32	93.67	5.22	10.17	4.77	9.29	32.26	28.79
9	81.67	27.18	77.3	4.92	13.6	3.7	7.83	31.03	25.26
10	80	29.21	83.3	6	10	4.71	9.32	25.2	36.92
11	87.67	21.59	120.3	5.72	12.8	4.53	8.53	29.31	29.12
12	83.67	29.14	86.3	5.1	10.3	4.74	12.92	32.52	34.71
13	79.67	40.07	101.3	5.32	14	5.29	5.84	31.86	18.35
14	86.67	38.99	88	4.6	12.3	5.32	7.89	27.01	29.21
15	81	33	82	4.46	12	3.68	6.71	21.8	30.81
16	80.67	38.87	88	6.17	10	4.34	7.53	29.31	25.64
17	79.67	31.34	80.67	5.15	10.3	4.39	7.24	27.59	26.24
18	79.33	38.39	87.33	7.07	12.3	4.56	15.39	31.53	48.35
19	83	38.9	59	3.91	10.3	4.46	10.18	33.46	30.42
20	82.33	30.73	84.33	4.79	8.3	4.76	15.92	39.65	40.16
21	85.61	33.07	76.67	5.85	11	4.15	12.84	35.3	36.36
22	84	23.85	81.5	6.33	9.67	3.77	18.87	40.81	46.2
23	92.33	35.46	108	7.33	8.19	4.18	12.08	30.11	38.39
24	76.33	33.27	90.33	5.89	8	5.51	8.61	28.6	30.14
25	82.33	32.95	92.33	3.67	10.3	4.76	5.89	24.01	24.55
Sakha 93	71.33	30.04	70	5	9.17	5.06	6.47	26.3	24.62
Total	**2179.7**	**832.2**	**2318.6**	**143.63**	**280.77**	**115.4**	**261.96**	**786.16**	**850.59**
Average	**83.38**	**32.01**	**89.18**	**5.52**	**10.79**	**4.44**	**10.07**	**30.24**	**32.71**
L.S.D.	**2.54**	**1.71**	**1.68**	**0.97**	**0.75**	**0.212**	**1.09**	**1.87**	**2.88**

Drought tolerance index (DTI) shown in Table (5). High tolerance was found for the genotypes 1, 3, 5,9,21 and 23.These genotypes gave the highest grain yield/plant under water stress conditions, while genotypes 4, 6, 12 and 18 gave intermediate tolerance for grain yield/plant.

The differences in behavior of wheat genotypes under water stress appear to be due to inherent potential to sustained drought conditions. It means that highly tolerant genotypes no. 1, 3, 5, 9, 21 and 23 appeared to be due to inherent potential to sustained water stress conditions and may be attributed to their variable genetic makeup and impaired physiological mechanisms of plant carried out in the presence of water. The finding is in agreement with various researchers [26,27,28]reported that yield and yield traits continue to be important in measuring the success of a genotype in heat-stressed environments. A genotype with stable and high yield across the environments would be more suitable as a cultivar and also as a donor parent for further breeding in hot environments that vary over the years and within a particular year across locations.

A drought susceptibility index (DSI), which provides a measure of stress resistance based on minimization of yield loss under stress as compared with optimum conditions. Low drought susceptibility index (DSI <1) mean higher stress tolerance, while high drought susceptibility index (DSI >1) mean higher stress sensitivity. Results in Table (5) showed that genotypes no. 2, 3, 8, 11,16 and 19 and the check variety (Sakha-93) had the lowest values of (DSI) indicating that they had more tolerant to drought stress. [29]reported that DSI values indicated the potential for screening durum wheat genotypes for drought response.

Drought tolerance index (DTI) shown in Table (5). High tolerance was found for the genotypes no. 1, 3, 5,9,21 and 23 and these genotypes gave the highest grain yield/plant under water stress conditions, while genotypes no.4, 6, 12 and 18 gave intermediate tolerance for grain yield/plant. SSI and DTI were also used by[30] to identify drought-tolerant bread wheat genotypes under different conditions and SSI was suggested as useful indicator for wheat breeding where the stress is severe while DTI were suggested if the stress is less severe. [31]reported that the stress susceptibility index (SSI) and sensitivity drought index (SDI) can be used to screen the drought resistant and stable genotypes.

In Al-Kanater the results revealed that all characters were reduced significantly under stress condition (Table 6). Genotypes no. 18,1 ,9 , 17 and 16 gave the highest grain yield under normal irrigation condition (L1), whereas genotypes 15,18,13,9 and 16 gave the highest grain yield under water stress condition (L2) comparing to check variety (Sakha-93).

The results in Table (6) showed that genotypes no. 3, 5, 8, 11, 12, 15 and 10 were highly tolerant to drought stress which had the lowest values of (DSI).While, genotypes no. 1, 4, 10,17,18 , 24 and check variety (Sakha-93) were susceptible to drought stress (DSI>1.00). Furthermore, all the other genotypes expressed as moderate tolerance to drought stress.

Drought tolerance index (DTI) shown in Table (6). The stress tolerance index was the highest in genotypes no.18, 15 and 9, while genotypes no. 3, 4, 20 and check variety (Sakha-93) gave intermediate tolerance index.

The genotypes mean performance of all the studied traits in Nubaria (new land) revealed low values (Table 7) as compared to the results obtained from the trials conducted in old land (Shebin EL-Kom and Al-Kanater). Plant height was drastically reduced in water stress condition as compared to that grown under stress and normal conditions in the old land. The taller genotypes had a high grain yield as a visual selection but exposed to attack the birds at maturity. Genotypes no. 13 and 24 were superiored on all lines for all locations at each level.

In Nubaria, flag leaf area ranged from 40.07 for genotypes no.13 to 21.59 for genotype no.11. Stay green of flag leaf area was detected in genotypes no. 1, 3, 16, 18, and 23 under drought conditions, optimum flag leaf area is important for photosynthetic activity as more area causes more transpiration losses[32].

Concerning the biological yield, the mean values ranged from 48.35 to 18.35. Genotypes no.4, 5, 7, 22 and 18 had the highest values of the biological yield. The best selected lines for grain yield were no, 5, 12, 18, 20, 22, and 21. So, these six lines are considered as a new germplasm need more evaluation to develop new high yielding wheat genotypes by repeat more yield trials for more years at Nubaria area.

The results demonstrated that the average mean performance of all genotypes were increased under water stress conditions compared to their values under normal conditions in Shebin El -Kom and vice versa in the second location ; AL-Kanater (Tables 5 and 6). This may be attributed to impact effect of heat stress due to delay sowing at AL-Kanater location and to potentials of some genotypes to tolerant of water deficit or due disability of some genotypes to produce high grain yield since new tillers death after irrigated (visual remarks), this illustrate decrease of spike number / plant under normal conditions in Shebin El-Kom. Water deficits have little impact on the rate of kernel growth, but often shorten the duration of filling. Also, water stress during flowering causes pollen sterility and failure of pollination. Drought during endosperm cell division decreases sink potential by inhibiting cell division and DNA endoreduplication and stress later during grain filling shortens the duration of filling by causing premature desiccation of the endosperm and by limiting embryo volume[33].

Therefore, based on this limited sample and environments, testing and selection under non-stress and stress conditions alone may not be the most effective for increasing yield under drought stress[34].

According to the results and suggestion reported in previous studies which concern to test new breeding materials under different environmental conditions to distinguish between tolerant and susceptible genotypes and select of the outstanding lines at each level to replace the deteriorated productivity, [35]stated that selection in the target stress condition has been highly recommended. On the other hand, other researchers have chosen a mid-way and believe in selection under both favorable and stress conditions[36,37]. [38]Reported that the extent of yield loss depends on the duration and intensity of the stress. [39]reported that simultaneous evaluation of the germplasm under near optimum conditions, to utilize high heritabilities and identify lines with high potential yield, and under stress conditions to preserve alleles for drought tolerance seems to be the best strategy.

Conclusion

25F6 bread wheat genotypes in addition to check variety (Sakha93) were evaluated under well water and water stress at three different locations. The results revealed that genotypes 10, 11, 12, 13 and 24 were early flowering at all locations under normal and water stress conditions. Genotypes 7, 2, 1, 9 and 3 gave the highest performance for no. of spikes/plant. The best selected genotypes for grain yield were 5, 12, 18, 20, 21 and 22 which exhibited high grain yield under spray irrigations at Nubaria. We concluded from this study that we could use those genotypes through the national wheat program to improve the wheat crop.

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