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Identifying Wheat Stress Tolerant Genotypes Among Some Bread Wheat Accessions Using Different Drought Tolerance Indices

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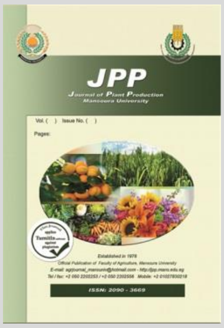

ABSTRACT

Thirty-nine genotypes of bread wheat (*Triticum aestivum* L.) collected from different regions in Egypt and two commercial varieties were used in this study, to estimate the tolerance indices and to establish the drought tolerance in 41 genotypes. Significant genotypes mean squares were detected for all studied traits, except number of spikes per m^2 and grain per spike under water stress. Using stress susceptibility index (SSI), genotypes 4, 6, 1, 31, 19, and 24 were classified as highly drought tolerant. According to stress tolerance index (STI), twelve genotypes were the top performer under stressed conditions. Twenty-nine genotypes showed lowest STI values (< 0.10) which implies that these genotypes were highly susceptible to drought. The greater values of yield stability index (YSI) were observed in genotypes 8,39,17,22,28,12,26 and 37. Based on sensitivity drought index (SDI) the six genotypes 4,6,1,31,19 and 24 revealed the highest values and were identified as tolerant under stress conditions. According to drought index (DI). Grain yield under stressed conditions (YS) was significantly and positively correlated with STI and DI. Yield in non-stress condition (YP) was significantly and positively correlated with YS, SSI, STI, SDI, and DI and negatively correlated with YSI. The total variation expressed between the two components was 99.70%. The variable that has the highest PCA1 value and the lowest PC2 was found excellent in screening genotypes under stress and non-stress conditions. Also, genotypes 17 and 37 are the most tolerant genotypes under water stress.

Keywords: Wheat, *Triticum aestivum* L., drought index, principal component, stress susceptibility index, tolerance indices, variability.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is among the main staple crops in Egypt. Increasing wheat production to narrow the deficiency between production and consumption is considered the major goal in Egypt as well as in most countries all over the world.

Drought stress is the most serious environmental problem that limits crop production in rainfed agriculture. The effect of lack of water (available at land gate) and lower rainfall during the sowing period seems to be the main reason for less acreage under wheat crop and causing the decline in wheat production. Therefore, breeding for drought-tolerant wheat genotype is an important function and target in the present scenario. For effective breeding of drought-tolerant wheat genotypes, a well-qualified selection is needed to identify the drought-tolerant wheat varieties. Some researchers reported earlier results of various drought tolerance indices such as Mitra (2001) who found that drought indices which afford a measure of drought based on loss of yield under drought-conditions in comparison to normal conditions have been applied for screening drought tolerant varieties. These indices are either established on drought resistance or susceptibility of varieties (Fernandez, 1992). Drought susceptibility index, stress tolerance index and stress index were the most useful to identify varieties differing in their response to drought. The benefit of the indices was confirmed by physiological markers of drought tolerance *i.e.* membrane injury and leaf water status. Rosielle and Hamblin (1981) and Grzesiak et al. (2019) stated that stress tolerance (TOL) as the differences in yield between the stress (Ys) and non-stress (Yp) environments and mean productivity (MP). Yield components of wheat that are relevant for drought screening include the following: number of spikelets per spike, number of kernels per spike, productive tiller number, and 1000- kernel weight. Reduced number of days to heading and maturity are also important when breeding for terminal drought stress tolerance since they allow for drought escape (Lopes et al.., 2012). Fernandez (1992) had divided accessions reaction based on their yields into four categories under stressed and non-stressed conditions: group A are varieties that have a high yield in both of conditions; group B are accessions that have a high yield under non-stressed conditions; group C including accessions which have a good yield under stressed conditions and finally group D are accessions which have a low yield in both conditions. Therefore, as Fernandez (1992) declared that the best index for stress tolerance selection is one that can be able to separate group A from others. Correlation analysis can be implemented to detect the relationship between indices and to determine the level of stress severity. The best indices are those which have the highest correlation with yield under both stress conditions

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and would be able to assort potential higher-yielding and drought-tolerant varieties (Mitra, 2001). Stress tolerance index (STI) is a useful tool for determining high yield and stress tolerance potential of the accessions (Fernandez, 1992)

Principal components analysis is used to decide the combination of indices as selection standard (Amiri et al.., 2014). The principal component analysis is one of the most successful methods for reducing the multiple dimensions of the discovered variables to a smaller intrinsic dimensionality of independent variables (Johnson and Wichern, 2007).

The purpose of the present study was to find out it based on drought tolerance indices trait it is possible to select wheat accessions, which display different tolerance to drought stress as well as determine which tests are most helpful for the selection of drought-resistant accessions.

MATERIALS AND METHODS

Two wheat experiments were carried out at Sids Research Station to study water stress effect on some wheat genotypes during the two winter seasons of 2017/2018 and 2018/2019. Thirty_nine wheat landraces, as well as two wheat cultivars (Sids 8 and Giza 168) were regenerated and evaluated for drought tolerance (Table 1). These landraces were collected from diverse areas in Egypt. Each plot consisted of 6 rows x 3m in length and 20 cm apart (plot size=3.6 m^2). The used design was a Randomized Complete Block Design (RCBD) with three replicates. Wheat genotypes were subjected to two water treatments where each water treatment was planted in a separate experiment and the first experiment was normally irrigated (five times) and the second experiment was irrigated only once at 20 days after planting.

Table 1. Names, bar code and sources of accessions used in the study.

Accession No.	Bar code	Sources	Accession No.	Bar code	Location	Accession No.	Bar code	sources
1	112278	Monufia	15	112689	Assiut	29	117280	Qena
2	112279	Monufia	16	112692	Assiut	30	117285	Sohag
3	112380	Dakahlia	17	112693	Giza	31	117289	Sohag
4	112381	Dakahlia	18	112699	Monufia	32	117290	Qena
5	112422	Sharqia	19	112706	North Sinai	33	117307	Qena
6	112423	Sharqia	20	112707	North Sinai	34	117308	North Sinai
7	112486	Qalyubia	21	112708	Beheira	35	117309	New Valley
8	112487	Qalyubia	22	112711	Beheira	36	117313	Sohag
9	112491	Beheira	23	112713	Dakahlia	37	117316	Sohag
10	112492	Beheira	24	112714	Gharbiya	38	117317	Bani Suef
11	112494	Qalyubia	25	117256	New Valley	39	117318	Assiut
12	112536	North Sinai	26	117257	New Valley	40	Sids 8	Wheat Research
13	112537	North Sinai	27	117260	New Valley	41	Giza 168	Department
14	112687	Sharqia	28	117279	Sohag			

Table 2. Studied traits.

Traits	Code
Number of spikes per m^2	NSm^2
1000- grain weight(g)	1000-KW
Number of grains per spike	NK/S
Grain yield per plot(kg)	GY/P
Stress susceptibility index	SSI
Stress tolerance index	STI
Yield stability index	YSI
Sensitivity drought index	SDI
Drought index	DI

Statistical analysis

Data were subjected to analysis of variance then equated the observed values to estimate the components of variance (Table 3). The variance components and coefficients of variation were estimated by the formula suggested by (Burton, 1952). Combined analysis of the two growing seasons was carried out. Means were compared by using least significant difference (LSD) at 5% level of probability (Snedecor and Cochran, 1980).

Table 3. Form of variance analysis combined over two seasons and mean squares expectations.

SOV	df	MS	Expectation of mean square
Replicates (r)	r-1	-	-
Year (Y)	y-1	-	-
Genotype (G)	g-1	M3	$Ó^2$ e + r $Ó^2$ gy + ry $Ó^2$ g
G x Y	(g-1) (y-1)	M2	$Ó^2$ e + r $Ó^2$ gy
Pooled error	y (r-1) (g-1)	M1	$Ó^2$ e

The drought tolerance indices were calculated as follow:

1- SSI = 1 – (Ys / Yp) / SI, where SI = 1 – (Ŷs / Ŷp) whereas SI is stress intensity and Ŷs and Ŷp are the means of all genotypes under stress and well water conditions, respectively. (Fischer and Maurer, 1978)
2- STI =(Ys/Yp)/ ȲS2 (Fernandez, 1992)
3- YSI = Ys / Yp (Bouslama and Schapaugh 1984).
4- SDI = =(Ys-Yp)/ Yp
5- DI = Ys × (Ys/Yp)/ $\bar{Y}_S$

Genotypic correlations were computed using variance and co-variances as suggested by (Johnson et al.., 1955). The principal component analysis method explained by Harman. (1976) was followed in the extraction of the components. Principal Components Analysis was performed using XLSTAT 2014 software.

RESULTS AND DISCUSSION

The analysis of variance for the 41 wheat genotypes under normal and water stress conditions for yield and its components is presented in (Table 4). Significant genotypes mean squares were detected for all the studied traits, except number of spikes per m^2 and number of grains per spike under water stress indicating the studied genotypes had responded differently to the different conditions, revealing the importance of the assessment of genotypes under different environments to determine the best genetic makeup for a particular environment. The extent of variability for any trait is very important for the improvement of a crop through breeding. These results agree with (El-Hosary et al. 2012 and Arab, 2016).

Table 4. Combined analysis of variances of 41 wheat under normal irrigation and drought stress over the two wheat growing seasons. Of 2017/2018 and 2018/2019.

	d.f	Normal irrigation				Water stress			
		NSm^2	1000-KW	NK/S	GY/P	NSm^2	1000-KW	NK/S	GY/P
year	1	18494.67**	2.69	193.99	0.06	7082.93	97.53**	32.10	2.58**
Error (a)	4	39.89	1.06	82.16	0.02	1383.54	2.61	16.72	0.01
Genotype	40	15625.75**	252**	348.95*	1.12**	16353.72	126.41**	307.37	0.66**
Genotype X year	40	401.46	90.18**	118.81	0.36**	157.07	46.13**	58.33	0.08**
Error (b)	160	363.60	2.75	34.78	0.02	1086.65	6.45	47.34	0.09
Total	245	2929.63	57.68	99.87	0.26	3434.19	32.78	90.75	0.19

***, ** significant at P< 0.05 and 0.01, respectively.**

Mean performance:

The mean performance of all the genotypes under normal and water stress conditions are presented in (Table 5). The maximum number of spikes per m^2 among all genotypes was attained by genotype 10 and genotype 17 under normal and water stress conditions. These results indicate that number of spikes per m^2 of these genotypes was slightly affected by water stress and they produced the highest grain yield/plot which confirms that number of spikes per m^2 is the most important yield component contributed to grain yield. Moreover, it is noticeable from the data in table (5) that number of spikes per m^2 of all genotypes was reduced under water stress treatment and reduction differed from genotype to another indicating genetic diversity among genotypes.

1000-grain weight under normal condition ranged from 25.55 g (genotype 1) to the maximum 57.57 g by (Sids 8) followed by 53.44 g (genotype 3) and 51.79 g (genotype 2).Genotype 1 attained a minimum value of 1000-grain weight (28.15g) and genotype 37 maximum value (50.67g) followed by genotype 11 (49.09g) and genotype 24 (48.93g) under water stress indicating the variability among the genotypes in their response to water stress conditions. However, the mean of 1000-grain weight under normal irrigation was 44.46g while recorded 43.68g under water stress conditions with a reduction of 0.78g (1.75%).

These results indicate that this traits can be used as selection criterion in breeding for drought tolerance. From Table 5 it can be noticed that many genotypes produced heavier grains under water stress treatment confirming the importance of this character in selection for drought tolerance.

The maximum number of grains per spike among all genotypes was attained by genotype 21 followed by genotype 3 and genotype 23 under normal irrigation conditions. Whereas under water stress conditions maximum number of grains per spike was attained by genotype 21 followed by Giza 168 and genotype 28. The average number of grains per spike under normal irrigation was 48.08 while under water stress was 44.74 with reduction of 3.34 grain/spike which represents 6.95%.

Grain yield per plot under normal irrigation conditions ranged from 0.97 kg (genotype 32) to the maximum 2.71 kg (genotype 21) followed by 2.52 kg/plot (Giza 168) and 2.49 kg/plot (genotype 2). However, Grain yield under stress treatment ranged from 0.81 kg /plot for genotype 32 to 2.38 kg /plot for genotype 17 with an average of 1.54 kg /plot while the average of grain yield under normal irrigation was 1.92 kg /plot with total reduction of 0.38 kg /plot which represent 19.79% reduction over all genotypes. Fischer and Maurer, 1978 showed that grain yield/plant under stress environments is dependent upon stress susceptibility yield potential, and stress escape. Therefore, grain yield/plant and its components remain as major selection criteria for improved adaptation to stress environments in many breeding programs. Genotype differences in grain yield per plot were reported by several investigators due to differences in yield attributes. The present results were greatly agreed with those obtained by (El-Hosary et al., 2012, Gomaa et al., 2014 and Thanaa et al., 2019).

Drought indices

Different drought tolerance indices were calculated based on grain yield per plot of the genotypes under normal irrigation (Yp) and water stress (Ys) conditions (Table 6). Based on the stress susceptibility index (SSI), genotypes 4, 6, 1, 31, 19, and 24 were classified as highly drought tolerant. SSI index favors genotypes with good yield under drought stress conditions; therefore, index can be utilized for identifying the genotypes which their performance is well under drought conditions. A high value of SSI indicated its more sensitivity to stress as reported by (Bruckner and Frohberg 1987). According to stress tolerance index (STI), the value of STI was classified into two groups i.e., STI > 1 for tolerant genotypes and STI < 1 value for sensitive genotypes. Genotype 17 showed the highest value of STI (1.54), followed by genotype 21 (1.50) and the other eleven genotypes. These 13 genotypes were the top performer under stressed conditions. Twenty-eight genotypes showed low STI values lower than 1.0 which implies that these genotypes were susceptible to drought-stressed conditions. STI values of sensitive line differed from 0.21 in genotype 33 to 0.95 in genotype 7 indicating variability of genotypes under study in their response to water stress condition. Genotypes with high STI values usually have high differences for yield under stressed and non-stress conditions, these, results are in agreement with (Fernandez, 1992 and Rosmaina et al. 2019). The yield stability index (YSI) was more important in discriminating drought-tolerant from susceptible genotypes. The greater values of YSI index were observed in genotypes 8,39,17,22,28,12,26 and 37. Genotypes with high YSI values were high-yielding under stress and yielding low under non-stress conditions, these results greatly agree with (Rosmaina et al. 2019). Based on sensitivity drought index (SDI) the six genotypes 4,6,1,31,19 and 24 revealed the highest values and were identified as tolerant under stress conditions. According to drought index (DI) index, the five genotypes 17, 37, 28, 23, and 21 displayed higher DI values as compared to other genotypes and were classified as drought-tolerant genotypes, as shown in Table 6.

Correlation coefficients

The correlation coefficients between Yp, Ys, and other quantitative indices of drought tolerance were calculated (Table 7). In other words, correlation analysis between grain yield and drought tolerance indices can be a good criterion for screening the best cultivars and indices used. Grain yield in stress conditions (Ys) was highly significantly and positively corrected with STI and DI. Yield in non-stress condition (Yp) was significantly and positively correlated with YS, SSI, STI, SDI, and DI and negatively correlated with YSI. STI was highly significantly and positively with DI and they can be the appropriate indices for screening wheat genotypes. Indicating that these criteria were more effective in identifying high yielding cultivars under different water conditions. (Farshadfar et al.. 2013 and Hooshmandi 2018) has reported similar findings to these results.

Table 5. Mean values of studied traits for 41 wheat genotypes evaluated under normal irrigation and drought stress combined over the two wheat growing seasons of 2017/2018 and 2018/2019.

	Number of spikes per m^2		1000- grain weight(g)		Number of grains per spike		Grain yield / plot(kg)	
	Normal	Drought	normal	Drought	normal	drought	normal	drought
1	409.83	397.50	25.55	28.15	44.48	35.74	1.61	1.06
2	440.83	402.00	51.79	43.12	51.33	44.53	2.49	1.77
3	444.50	416.83	53.44	48.28	63.87	51.48	2.21	1.68
4	375.33	365.83	38.90	36.50	43.67	45.20	1.98	1.28
5	334.33	301.00	40.61	43.37	46.08	35.23	1.85	1.40
6	394.33	359.50	51.73	43.84	55.87	37.60	2.28	1.49
7	395.50	362.33	46.59	46.42	53.35	40.06	2.06	1.70
8	409.50	395.00	38.17	36.91	36.14	32.38	1.42	1.41
9	360.83	332.00	46.03	46.63	51.07	47.28	2.10	1.55
10	539.00	535.67	45.43	48.18	53.58	41.80	2.30	1.86
11	450.83	420.67	45.61	49.09	56.08	44.97	2.08	1.57
12	370.67	347.67	39.86	43.33	41.64	39.50	1.55	1.51
13	417.50	400.67	44.77	44.45	49.38	44.27	2.06	1.59
14	369.83	364.33	48.97	39.63	57.71	47.43	2.48	1.80
15	411.50	384.33	51.70	47.27	46.59	44.10	2.19	1.79
16	333.33	324.33	37.78	41.53	46.43	47.42	2.00	1.61
17	506.33	512.33	49.28	43.84	54.27	45.99	2.43	2.38
18	383.33	374.33	50.71	44.96	49.88	40.50	1.85	1.67
19	406.50	379.33	41.61	43.28	62.19	46.83	2.06	1.36
20	369.17	364.33	42.60	43.42	45.03	35.57	1.48	1.12
21	415.00	396.17	45.82	46.88	68.53	63.60	2.71	2.03
22	283.33	274.33	36.01	35.22	46.92	38.67	1.30	1.27
23	452.50	425.17	51.44	47.64	63.72	54.22	2.15	2.06
24	427.50	399.33	47.40	48.93	58.15	39.93	2.42	1.60
25	355.83	337.00	45.38	42.00	54.35	44.53	1.85	1.65
26	404.83	392.00	50.69	45.25	45.08	46.33	1.42	1.38
27	282.83	268.67	47.27	46.54	38.83	39.08	1.64	1.45
28	395.83	377.00	43.39	44.60	46.38	56.73	2.11	2.06
29	309.83	292.00	46.38	41.04	37.13	36.38	1.01	0.96
30	406.00	377.00	46.01	35.73	50.33	32.38	1.58	1.40
31	407.00	392.00	46.59	44.87	44.18	45.00	2.19	1.45
32	390.83	372.00	28.82	34.77	41.98	40.57	0.97	0.81
33	444.50	427.00	41.92	39.77	56.37	43.77	1.82	1.44
34	401.17	367.00	48.31	43.33	43.20	43.87	2.43	1.64
35	427.00	412.00	33.44	41.03	55.27	36.33	1.62	1.47
36	406.67	387.00	44.72	44.59	57.22	49.37	1.48	1.06
37	446.67	428.67	48.56	50.67	53.53	46.03	2.14	2.09
38	330.50	308.67	38.14	40.88	37.94	41.37	1.49	1.30
39	361.67	342.00	44.11	46.01	46.94	47.47	1.17	1.15
40	416.67	397.00	57.57	44.81	46.73	33.04	2.09	1.47
41	408.50	382.00	39.77	46.93	53.97	62.50	2.52	1.98
Mean	397.50	377.90	44.46	43.26	50.13	43.64	1.92	1.54
L.S.D 0.05%	30.75	53.15	2.68	4.10	9.51	11.10	0.23	0.48
Minimum	282.83	268.67	25.55	28.15	36.14	32.38	0.97	0.81
Maximum	539.00	535.67	57.57	50.67	68.53	63.60	2.71	2.38

Table 6. Estimation of sensitivity rate of 41 wheat genotypes by different drought tolerance indices under normal and stressed conditions.

	YP	YS	SSI	STI	YSI	SDI	DI
1	1.61	1.06	1.76	0.46	0.66	1.76	0.68
2	2.49	1.77	1.48	1.20	0.71	1.48	1.15
3	2.21	1.68	1.24	1.01	0.76	1.24	1.09
4	1.98	1.28	1.82	0.69	0.65	1.82	0.83
5	1.85	1.40	1.24	0.71	0.76	1.24	0.91
6	2.28	1.49	1.80	0.92	0.65	1.80	0.96
7	2.06	1.70	0.90	0.95	0.83	0.90	1.10
8	1.42	1.41	0.06	0.54	0.99	0.06	0.91
9	2.10	1.55	1.35	0.89	0.74	1.35	1.00
10	2.30	1.86	0.98	1.16	0.81	0.98	1.20
11	2.08	1.57	1.26	0.88	0.75	1.26	1.01
12	1.55	1.51	0.16	0.64	0.97	0.16	0.98
13	2.06	1.59	1.18	0.89	0.77	1.18	1.03
14	2.48	1.80	1.41	1.21	0.73	1.41	1.16
15	2.19	1.79	0.93	1.07	0.82	0.93	1.16
16	2.00	1.61	1.00	0.88	0.81	1.00	1.04
17	2.43	2.38	0.11	1.57	0.98	0.11	1.54
18	1.85	1.67	0.50	0.84	0.90	0.50	1.08
19	2.06	1.36	1.74	0.76	0.66	1.74	0.88
20	1.48	1.12	1.27	0.45	0.75	1.27	0.72
21	2.71	2.03	1.29	1.50	0.75	1.29	1.31
22	1.30	1.27	0.12	0.45	0.98	0.12	0.82
23	2.15	2.06	0.22	1.21	0.96	0.22	1.33
24	2.42	1.60	1.74	1.05	0.66	1.74	1.04
25	1.85	1.65	0.54	0.83	0.90	0.54	1.07
26	1.42	1.38	0.14	0.54	0.97	0.14	0.90
27	1.64	1.45	0.61	0.64	0.88	0.61	0.94
28	2.11	2.06	0.12	1.18	0.98	0.12	1.33
29	1.01	0.96	0.27	0.26	0.95	0.27	0.62
30	1.58	1.40	0.59	0.60	0.89	0.59	0.91
31	2.19	1.45	1.75	0.86	0.66	1.75	0.94
32	0.97	0.81	0.81	0.21	0.84	0.81	0.53
33	1.82	1.44	1.08	0.72	0.79	1.08	0.93
34	2.43	1.64	1.67	1.08	0.67	1.67	1.06
35	1.62	1.47	0.47	0.65	0.91	0.47	0.96
36	1.48	1.06	1.48	0.43	0.71	1.48	0.68
37	2.14	2.09	0.13	1.22	0.97	0.13	1.35
38	1.49	1.30	0.64	0.53	0.87	0.64	0.84
39	1.17	1.15	0.07	0.37	0.99	0.07	0.75
40	2.09	1.47	1.53	0.83	0.70	1.53	0.95
41	2.52	1.98	1.10	1.35	0.79	1.10	1.28

Grain yield under normal condition (YP), grain yield under water stress (YS), stress susceptibility index (SSI), stress tolerance index (STI), yield stability index (YSI), sensitivity drought index (SDI) and drought index (DI)

Table 7. Correlation between drought tolerance indices with grain yield under normal irrigation and drought stress conditions.

	YP	YS	SSI	STI	YSI	SDI
YS	0.79**					
SSI	0.46**	-0.16				
STI	0.93**	0.95**	0.14			
YSI	-0.46**	0.16	-1.00**	-0.14		
SDI	0.46**	-0.16	1.00**	0.14	-1.00	
DI	0.79**	1.00**	-0.16	0.95**	0.16	-0.16

***, ** significant at P< 0.05 and 0.01, respectively. Grain yield under normal condition (YP), grain yield under water stress (YS), stress susceptibility index (SSI), stress tolerance index (STI), yield stability index (YSI), sensitivity drought index (SDI) and drought index (DI)**

Principal components analysis:

To estimate the relationship between the 41 genotypes and drought tolerance indices, the principal component analysis was applied (Table 8). The total variation expressed between the two components was 99.70% (Table 8). The first PC explained 54.19% of the total variation and the second PC explained 45.51% of the total variability. The variable that has the highest PCA1 value and the lowest PC2 was found excellent in screening genotypes under stress and non-stress conditions. Based on the results of the PCA, the YP and STI index have the highest values in PC1 and the lowest values in PC2, so that both indices can be used to screen the drought-tolerant genotypes in the present study. The selection of YP and STI as criteria for screening the drought-resistant genotypes is linked to severe stress intensity.

Table 8. Loadings of PCA for grain yield under normal irrigation and water stress conditions as well as drought tolerance indices.

	PC1	PC2	PC3
YP	0.99	0.07	0.02
YS	0.84	-0.55	-0.05
SSI	0.40	0.91	-0.01
STI	0.96	-0.28	0.08
YSI	-0.40	-0.91	0.01
SDI	0.40	0.91	-0.01
DI	0.84	-0.55	-0.05
Eigenvalue	3.79	3.19	0.01
Variability (%)	54.19	45.51	0.19
Cumulative %	54.19	99.70	99.88

Grain yield under normal condition (YP), grain yield under water stress (YS), stress susceptibility index (SSI), stress tolerance index (STI), yield stability index (YSI), sensitivity drought index (SDI) and drought index (DI)

CONCLUSIONS

Results obtained by analysis of variance were significant for all the studied characters, except number of spikes per m^2 and number of grains per spike under water stress indicating that the studied genotypes had responded differently to the different conditions, indicating the importance of the assessment of genotypes under different environments to determine the best genetic makeup for a particular environment. Comparisons of mean show that genotypes 21, Giza 168 and 2 have the highest yield under normal irrigation conditions and genotypes 17 and 37 are the most tolerant genotypes under water stress. STI and DI indices showed a positive and high correlation with grain yield under stress and non-stress conditions which are suitable to identify cultivars with high yield in drought stress tolerance. Principle component analysis showed that the most variance among data is justified by two first components so that the first component justifies more than 54% of general changes.

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تحديد الطرز الوراثية المقاومة للإجهاد في بعض تراكيب قمح الخبز باستخدام مؤشرات تحمل الجفاف المختلفة

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تم اجراء هذا البحث بمحطة البحوث الزراعية بسدس خلال موسمي 2017/ 2018 و 2018 /2019 بإستخدام 39 تركيب وراثي مختلف من قمح الخبز مجمعة من مناطق مختلفة من مصر بالإضافة لصنفين تجاريين بهدف تقييم مؤشرات الاجهاد المختلفة. أظهرت التراكيب الوراثية معنوية لمعظم الصفات المدروسة فيما عدا عدد السنابل في المتر المربع وعدد حبوب السنبلة تحت ظروف نقص المياه. باستخدام مؤشر القابلية للاجهاد (SSI) تم تصنيف التراكيب 4و6و1و 31و19 و24 علي أنها شديدة التحمل للجفاف وباستخدام مؤشر تحمل الاجهاد (STI) أظهرت اثنا عشر تركيبا وراثيًا أداءً أفضل في ظل ظروف الإجهاد. كما أظهرت تسعة وعشرون تركيبا وراثيًا أدنى قيم ل (STI) مما يعني أن هذه التراكيب الوراثية كانت شديدة التأثر بنقص المياه. كانت القيم العالية لمؤشر ثبات المحصول الناتج (YSI) في التراكيب 8 و 39 و 17 و 22 و 28 و 12 و 26 و 37 . وباستخدام مؤشر حساسية الجفاف (SDI) ، أظهرت ستة تراكيب الوراثية 19،31،1،6،4 و 24 قيم عالية وتم تصنيفها على أنها متحملة تحت ظروف نقص المياه. وباستخدام مؤشر الجفاف (DI) ، أظهرت خمسة تراكيب وراثية 17 و 37 و 28 و 23 و 21 قيمًا أعلى لـ DI مقارنة بالتراكيب الوراثية الأخرى وتم تصنيفها على أنها تراكيب وراثية تتحمل الجفاف. أظهرت النتائج ارتباط موجب ومعنوي لمحصول الحبوب (YS) تحت ظروف الاجهاد مع كلا من مؤشر تحمل الاجهاد (STI) ومؤشر الجفاف (DI). كما أظهرت النتائج ارتباط معنوي وموجب لمحصول الحبوب (YP) تحت ظروف الري الطبعية مع كلا من محصول الحبوب (YS) تحت ظروف الاجهاد و مؤشر القابلية للاجهاد (SSI) و مؤشر تحمل الاجهاد (STI) و مؤشر حساسية الجفاف (SDI) و مؤشر الجفاف (DI). كما كان هناك ارتباط سالب ومعنوي مع محصول الحبوب (YP) تحت ظروف الري الطبعية و مؤشر ثبات المحصول الناتج (YSI) مما يعني أن هذه المؤشرات كانت الافضل في انتخاب أفضل التراكيب الوراثية تحت ظروف الري المختلفة. كما أظهرت النتائج أن مجموع التباين الكلي للمكونين الأول والثاني 99.77 % . وجد أن المتغير الذي يحتوي على أعلى قيمة للمكون الرئيسي الأول و أقل قيمة للمكون الرئيسي الثاني كان الافضل لانتخاب التراكيب الوراثية تحت ظروف الجفاف والري الطبيعية