Egypt. J. Plant Breed. 10(1): 223-246 (2006)

STABILITY PARAMETERS OF SOME BREAD WHEAT GENOTYPES (*Triticum aestivum*) IN NEW AND OLD LANDS UNDER UPPER EGYPT CONDITIONS

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ABSTRACT

This investigation was conducted on forty bread wheat genotypes of diverse origin that were chosen for their tolerance to abiotic stresses (heat tolerance) grown under eight environments (the combinations of 2 seasons x 2 planting dates x 2 locations i.e. Assiut (El-Kosia district) and Kcom-Ombo Res. Station during two successive seasons 2003/2004 and 2004/2005, to evaluate their performances and the their stability. The studied traits included days to heading, days to physiological maturity, number of kernels/spike, 1000-kernel weight and grain yield t/ha. Wheat genotypes showed different responses to environments. Delaying sowing date reduced number of days to heading, maturity date, number of kernels/spike, 1000-kernel weight (g) and grain yield t/ha by an average of 13.65, 13.47, 25.77, 27.31 and 28.96%, respectively, compared with the recommended sowing date.

The joint regression analysis of variance indicated highly significant differences among genotypes for all the studied characters. The heterogeneity of linear responses and remainder sums of squares were highly significant for all the studied traits. The regression coefficients were positively correlated with the mean performance, indicating that high yielding genotypes had generally, positive βi values and revealed a good response to the improving environments. However, four genotypes (No. 5, 8, 9 and 20) could be considered the best, since they had higher grain yield and acceptable stability. Such genotypes could be used in a breeding program because they had high yielding capacity and high stability performance.

Key words: ***Wheat genotypes, Triticum aestivum, Heat stress, Phenotypic and genotypic stability parameters, Ecovalence.***

INTRODUCTION

Wheat is one of the most important food crops. It is grown under a wide range of climatic conditions where suffering various stresses throughout the growing season. Heat stress is a common abiotic stress that causes stunted plants, reduced tillering, and accelerates development leading to small heads, shriveled grains and finally translated to low yields. Respecting agronomic traits affected by these abiotic stresses such as days to heading, days to maturity, plant height and grain yield can be found easily identifiable traits as indices for heat tolerance. Therefore, evaluation of breeding materials under different environments has to be done. Understanding the nature of genotype *x* environment interaction empower breeders to test and select the more efficient genotypes. Breeding genotypes with wide adaptability has long been a universal goal among plant breeders. To achieve this goal, evaluating breeding lines over time and space has become an integral part of any plant breeding program.

The obscure impact of genotype environment interaction (G *x* E) on the relative performance and stable genotypes across environments is so important that it forms challenging difficulty to the breeder in developing superior cultivars adaptation (Eberhart and Russell 1966). Furthermore, genotype x environment interactions has been shown to reduce progress from selection (Comstock and Moll 1963). On the other hand, stability may, in fact, depends on holding certain morphological and physiological attributes steady as long as possible and allowing others to vary.

Several investigators had attempted to estimate G x E numerically. Wricke (1962) developed a statistical estimate of stability, which squared and summed GE- interaction effects across all environments and termed it as ecovalence (Wi). Other two estimates developed by Eberhart and Russell (1966). The first is the regression coefficient (b_i) of a line on environmental indices that estimate its response to favorable conditions while the remainder sums of squares after the regression (S^2d_i) illustrates the latter un-described interaction effects. They defined a stable cultivar as one which had a regression coefficient (b_i) equal to 1.0 and with (S^2d_i) equal to, or does not deviate significantly from 0.0. Apparently, a cultivar that did not meet both qualifications would be closed as unstable. However, an ideal cultivar would have both a high average performance over a wide range of environments plus stability. Francis and Kannenberg (1978) used the conventional CV% (coefficient of variation due to G x E) of each genotype as a stability measure.

Abd-Elghani *et al* (1994) stated that regression analysis as well as grain yield *per se* could be useful tools for identifying high yielding thermo-tolerance genotypes. Ismail (1995) evaluated 20 genotypes of wheat under different environments and observed significant interactions between locations x dates for heading date, 1000-kernel weight and grain yield. Also Kheiralla *et al* (1997) evaluated 12 bread wheat cultivars under different environments and found that, the two components of G *x* E interactions i.e., heterogeneity between regressions and the remainder component, were statistically significant, which indicated the presence of G *x* E interactions, for grain yield. The variations in *bi* values suggested that the genotypes responded differently to the different environments. On the other hand, El-Morshedy *et al* (2000) revealed that most of the variations in the total sum of squares of days to heading and grain yield were due to the environmental variations which were, in consequences, attributed to the main effects of the used environmental factors (year, sowing date and irrigation) while the interaction of year x sowing date had the second importance. The differences in stability estimates among wheat cultivars, hybrids, and multi-lines across a range of environments were due to the genetic variations (Mahal *et al* 1988). Also, Sharma *et al* (1987) revealed that winter wheat genotypes significantly differed for grain yield and found that the G *x* E interaction was also significant for this trait. They added that the regression coefficients ranged from 0.75 to 1.17 for grain yield.

The objectives of this study were to examine the magnitude of G *x* E interactions as well as to assess the stability parameters of grain yield and its components of the 40 genotypes of wheat under abiotic stresses (heat stress) of the Upper Egypt conditions to identify the most stable genotypes under these conditions. Finally, the probability of selecting certain lines as being stable over different environments will be investigated.

MATERIALS AND METHODS

Forty bread wheat *(Triticum aestivum)* genotypes were used in this study. Entries used were; (i) check cultivars; and (ii) selected entries from exotic material. Studied entries and their origins are listed in Table (1). These diverse entries were evaluated at two locations under two sowing dates during 2003/2004 and 2004/2005 seasons as follows:-

In 2003/2004 season, the recommended sowing date was 22th November (D1) and the late sowing was 21th December (D2) at Assiut (L1); the research farm has a newly reclaimed sandy soil. While the recommended sowing date in the second location was 20th November (D1) and the late sowing was 19th December (D2) in an old cultivated soil at Kom-Ombo (L2). In 2004/2005season, the recommended sowing date at L1 was 20th November (D1) and the late sowing was 19th December (D2). While at L2, D1 was 18th November and D2 was 18th December. The experimental design was a randomized complete block with three replicates. Each plot consisted of 6 rows, 3.5m long and 20 cm apart. Seeds were hand sown in drills. All other cultural practices were applied as recommended.

Table 1: The entry name, pedigree and origin of the forty studied wheat genotypes.

Ent. No.	Name/Pedigree (lines or crosses)	Origin	Ent. No.	Name/Pedigree (lines or crosses)	Origin
1	Hahn/2* Weaver	CIMMYT	21	Esda /Shwa / /Bcn.	CIMMYT
2	Star//Kauz/Star.	CIMMYT	22	Opata /Rayon // Kauz.	CIMMYT
3	Mnch/3* Bcn.	CIMMYT	23	Parus // Bow / Nkt-	CIMMYT
4	Ures/Bow// Opata.	CIMMYT	24	Sham-4/ Debeira.	SUDAN
5	Pvn //Kauz /Pvn	CIMMYT	25	Mayon"s"//Crow"s"/Vee"s".	CIMMYT
6	Debeira.	INDIA	26	Kauz*2/Yaco// Kauz.	CIMMYT
7	Cham60/3/Seri*3//RL6010/4/*R	SUDAN	27	Caza /Kauz//Kauz.	CIMMYT
8	Seri/Nkt//2*Kauz.	CIMMYT	28	Seri*4//Aga / 6*Yr /3/ Seri.	SUDAN
9	Ures /Jun // Kauz.	CIMMYT	29	KzaTtsas"s"Wm73884-2Con.	SUDAN
10	Vorona /Kauz /Kauz.	CIMMYT	30	Tevee"s"/ Kauz"s".	SUDAN
11	Sw89-3064/Star.	CIMMYT	31	Attila /3*Bcn.	CIMMYT
12	Debeira/HD2189-1.	SUDAN	32	Irena/ Weaver.	CIMMYT
13	Tjb368-251/Buc /Kauz /3/ Kauz.	SUDAN	33	Kauz/ /Kauz /Star.	CIMMYT
14	Bow"s"/Buc"s"//Sudan#1.	SUDAN	34	HD2189/S948-Ascc7/ Vee.	SUDAN
15	Kauz / Star.	CIMMYT	35	Fow-2//Ns732/Her.	CIMMYT
16	Oasis /5 *Bor I95.	CIMMYT	36	Attila/3/Hui/Cars//Chen/Chto/4/Attila.	CIMMYT
17	Pfau / Weaver.	CIMMYT	37	Oasis/Skauz//4*Bcn.	CIMMYT
18	Star // Kauz / Lucu-M-49M	SUDAN	38	Chil/2*Star.	CIMMYT
19	Mayon-1/3/T1/ Tob//Ald"s".	CIMMYT	39	Ure"s"/ Kauz.	SUDAN
20	Giza168.	EGYPT	40	Sakha93.	EGYPT

Data were recorded for five agronomic characters

Days to heading were measured as number of days from planting to 50% of the heads appeared beyond the flag leaf sheath, Physiological maturity date was measured as number of days from sowing to date when peduncle leaf became yellow, Number of kernels/spike was estimated as an average of grains of ten spikes, 1000-Kernel weight was determined as an average weight of 1000 grains from the bulk of the plot and grain yield/plot was computed from the weight of grains from the four middle rows (plot area= 2.8 m^2).

One hectare= 10,000 m^2

The analysis of variance procedure of Comstock and Moll (1963) was adopted to test the significance of location, year, genotype, and first and second order interactions. The year and location effects were assumed to be random while genotypic effect was analyzed as fixed.

According to Eberhart and Russell (1966) the mathematical model used herein. A significant F value would indicate that the S^2di was significantly different from zero. The hypothesis that each regression coefficient equaled unity was tested by the t test using the standard error of the corresponding b_i value.

The estimates C.V. %, bi, βi, S2di and Wi were calculated for each of the 40 genotypes over all environments. Where; C.V. %= Si / $\bar{X}_i$ x 100 (Francis and Kannenberg 1978), bi, and S^2d_i were estimated according to Eberhart and Russell (1966) and $\beta_i = b_i - 1$.

The stability parameter postulated by Wricke (1962) depends on the $(GE)_{ik}$ effects squared and summed across all environments that was denoted as ecovalence (Wi). It may be estimated as follows:

Ecovalence: $Wi = \sum(X_{ik} - X_{i.} - X_{.k} + X_{..})^2 / (E-1)$

Where X.. is the general mean, Xi. is the genotype mean for i^{th} genotype across used environments and $X_{.k}$ is the environmental mean for k^{th} environment or genotypes mean in this environment.

RESULTS AND DISCUSSION

The combined analysis of variance showed highly significant differences between years and between locations for heading date, physiological maturity, number of kernels/spike, 1000-kernels weight gm and grain yield t/ha Table (2). These results reflect the differences in climatic conditions prevailing during the growing seasons. The main effect of sowing dates was highly significant for all traits as it would be expected for difference between optimum and late sowing dates.

The studied genotypes significantly differed for all traits, reflecting the genetic diversity between them. The first order interaction years x dates was significant for all traits except grain yield /ha. On the other hand, significant interaction between locations and dates was found for heading date, physiological maturity, number of kernels/spike and 1000-kernels weight gm. These results indicate that the effect of sowing date varied from location to another for mentioned traits. Moreover, the effect of sowing dates was more pronounced than that of years and locations for all studied traits except grain yield. The combined analysis of variance showed significant second degree of interaction among genotypes, dates and locations for all studied characters except grain yield, Table (2).

Table 2. Mean squares of the combined analysis of variance for each of the studied characters overall wheat accessions and environments

Source of variance	d.f	Mean Square (M.S) of variance for all studied characters				
		Days to heading	Days to maturity	No. of kernels/spike	1000-kernel weight gm	Grain yield (t/ha.)
Year (y)	1	1467.676**	614.400**	7040.421**	748.749**	52.813**
Rep/Y(Ea)	4	11.742	2.518	11.743	11.942	0.550
Location(L)	1	3860.026**	595.350**	26732.332**	1043.584**	769.063**
YxL	1	2428.884**	190.817**	7540.687**	1775.616**	9.392*
Error(b)	4	0.802	1.036	3.977	8.063	0.609
Dates (D)	1	36840.426**	77226.938**	50277.610**	29749.603**	607.730**
YxD	1	148.051**	214.704**	223.330**	681.279**	0.440
LxD	1	112.751*	1565.704**	752.126**	28.325**	0.206
YxLxD	1	151.209**	301.504**	117.063**	454.273**	5.744**
Error (c)	8	10.528	9.719	4.695	2.377	0.328
Genotypes(G)	39	91.031**	59.431**	89.401**	47.665**	2.780**
YxG	39	8.159**	5.103	53.138**	13.093**	0.499
LxG	39	38.842**	15.698**	115.302**	25.904**	2.083**
YxLxG	39	7.265**	5.353	43.526**	15.628**	0.578*
DxG	39	12.315**	12.320**	73.979**	18.324**	0.828**
YxDxG	39	7.367**	4.916	33.776**	6.217**	0.400
LxDxG	39	14.990**	13.236**	63.301**	21.323**	0.552
YxLxDxG	39	4.534	6.173	26.135**	4.770**	0.497
Pooled error	624	3.375	6.342	10.310	2.836	0.398
C.V	-	2.17%	2.03%	6.56%	4.78%	13.41%

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

Accordingly, there were differential responses among genotypes to sowing dates and locations. These results indicate that wheat genotypes responded differently to the different environmental conditions, suggesting the importance of assessment of genotypes under different environments in order to identify the best genetic make up for a particular environment. Similar results were obtained by Ismail (1995), Kheiralla *et al* (1997) and El-Morshidy *et al* (2001).

Performance of genotypes

Days to 50% heading

Results shown in Table (3) revealed that the overall mean of number of days to heading were 85.76 and 83.29 days on average for the two years, respectively; 90.72 and 78.33 days for normal and late sowing dates, respectively; and 86.53 and 82.52 for the two locations, respectively. The heat stress imposed on the wheat plants in the late sowing dates speed flowering process so that the average number of days to heading decreased by 12 days. These results may be due to the fact that heat units required for wheat flowering were accumulated on short times in the late sowing

Table 3. Average performance of the studied characters combined over forty genotypes for years, sowing dates and locations.

Item	Days to heading (HD)	Days to maturity (MD)	No. of kernel/spike	1000-kernel weight gm	Grain yield (T/ha)
			Year (Y)		
Y1	85.76	124.98	51.66	36.10	4.937
Y2	83.29	123.38	46.24	34.34	4.467
L.S.D 0.05	0.61	0.28	0.61	0.62	0.132
			Sowing dates		
D1	90.72	133.15	56.19	40.79	5.498
D2	78.33	115.22	41.71	29.65	3.906
L.S.D 0.05	0.48	0.46	0.32	0.23	0.085
			Locations		
L1	86.53	124.97	43.67	34.18	3.807
L2	82.52	123.40	54.23	36.26	5.597
L.S.D 0.05	0.16	0.18	0.36	0.51	0.139

combined with high temperature. It is clear that delaying sowing date reduced number of days to heading by an average of 13.65% as compared with the recommended date. These results are in agreement with those obtained by Waraich *el al* (1982) and El-Morshidy *et al* (2001). French *et al* (1979) showed that both high temperature and increasing day length markedly reduced the flowering stages.

Average number of days to heading of genotypes overall environments ranged from 81.00 for genotype No 5 to 89.75 days for genotype No 14 with an average of 84.70 days over all genotypes (see Table 4).

Days to physiological maturity

Days to maturity were significantly affected by years, locations, sowing dates and genotypes. These results indicated that the maturity of wheat genotypes greatly affected when they were grown at different dates and locations. The average number of days to maturity ranged from 115.22 to 133.15 days, regarding sowing dates (Table 3).

Table 4. Means and estimated stability parameters of days to heading of each accession (G) of wheat genotypes over all the used environments (E).

Genotype	Mean	C.V.%	bi±S.E	βi	S^2d_{ii}	Wi
1	81.62	8.83	0.958±0.094	-0.042	10.058**	2.967
2	85.12	10.76	1.244±0.056	0.244**	3.668	4.235
3	83.00	10.02	1.107±0.104	0.107	12.404**	4.161
4	86.50	8.58	0.937±0.159	-0.063	28.563**	8.371
5	81.00	8.88	0.925±0.135	-0.075	20.649**	6.196
6	82.62	10.15	1.079±0.157	0.079	27.805**	8.281
7	87.87	9.65	1.136±0.093	0.136	9.786*	3.787
8	85.00	7.33	0.827±0.084	-0.173	8.023*	3.896
9	84.62	7.96	0.849±0.145	-0.151	23.865**	8.031
10	85.50	9.38	1.059±0.115	0.059	14.971**	4.464
11	83.62	11.23	1.122±0.255	0.122	73.277**	21.731
12	86.50	9.63	1.075±0.153	0.075	26.487**	7.871
13	86.50	8.83	1.035±0.055	0.035	3.576	1.086
14	89.75	8.93	1.031±0.151	0.031	25.766**	7.412
15	87.87	9.41	1.083±0.133	0.083	19.920**	6.058
16	87.50	8.96	1.043±0.099	0.043	11.226**	3.307
17	83.25	8.56	0.960±0.067	-0.040	5.280	1.595
18	86.12	9.11	1.054±0.082	0.054	7.637*	2.335
19	83.25	8.41	0.953±0.039	-0.047	1.838	0.645
20	81.37	7.34	0.790±0.084	-0.210*	8.167*	4.697
21	85.75	8.83	0.958±0.160	-0.042	29.083**	8.405
22	82.75	8.22	0.916±0.064	-0.084	4.765	1.741
23	84.25	8.65	0.983±0.064	-0.017	4.804	1.387
24	86.00	8.54	0.960±0.121	-0.040	16.488**	4.796
25	85.87	8.79	1.017±0.070	0.017	5.699	1.644
26	84.25	9.47	1.077±0.071	0.077	5.786	1.966
27	84.75	9.33	1.066±0.072	0.066	6.005	1.948
28	86.50	9.59	1.118±0.079	0.118	7.162	2.786
29	86.37	9.16	1.059±0.088	0.059	8.832*	2.712
30	83.00	7.83	0.873±0.068	-0.127	5.428	2.418
31	84.87	7.90	0.906±0.058	-0.094	3.933	1.601
32	82.62	8.56	0.946±0.080	-0.054	7.272	2.231
33	83.25	8.37	0.946±0.044	-0.054	2.306	0.816
34	84.62	8.77	0.971±0.120	-0.029	16.258**	4.688
35	82.75	8.66	0.969±0.059	-0.031	4.086	1.220
36	85.25	8.00	0.905±0.091	-0.095	9.531*	3.209
37	84.12	9.77	1.102±0.089	0.102	8.992*	3.128
38	85.25	9.23	1.053±0.089	0.053	9.051*	2.737
39	85.00	8.65	0.985±0.080	-0.015	7.322	2.104
40	82.00	9.45	0.923±.212	-0.077	50.504**	14.746
Grand mean	84.69					
LSD $_{0.05}$	1.039					

r ($\bar{X}$, bi) = 0.411**

*, ** Significantly different from unity for (bi) and from zero for (S^2d_i) at 0.05 and 0.01 probability levels, respectively.

Average number of days to physiological maturity ranged from 121.75 days for genotype No.3 to 127.88 days for genotype No. 12 with an average over all genotypes of 124.33 days (Table 5). It is clear that delaying planting date caused a reduction in number of days to physiological maturity by an average of 13.47% compared with the recommended sowing date. Late maturing genotypes have a relatively better response under the stress in terms of the availability of assimilates, especially during post anthesis for grain growth (Blade and Baker 1991). However, early genotypes would escape the stress, especially when the stress occurred at the end of the growing season (Blum 1988 and Sullivan and Jordan 1991). These finding are also in agreement with the results obtained by Abdel-Shafi *et al* (1999).

Number of kernels/ spike

Data presented in Table (3) showed that recommended sowing date produced the highest number of kernels/spike (56.19 kernels) compared to late one (41.71 kernels/ spike). The average number of kernels/spike ranged from 43.65 for genotype No.40 to 53.12 kernels for genotypes No. 37 with an average number of 48.95 kernels /spike (Table 6). The results indicated that the recommended sowing gave a high number of kernels/spike compared with the late one. High air temperature (26°C) for about 6 to 8 days prior to apex double ridge through terminal spikelets formation in late planting reduced the number of kernels/spike (Frank *et al*, 1987). However, Fischer (1985), and Savin and Slafer (1991) stated that accelerating development during active spike growth through high air temperature reduced the finial number of grains, despite the fact that prevailing temperature increase the rate of spike growth. Similar results were obtained by Abdel-Shafi *et al*1999) and El-Morshidy *et at* (2001).

1000-Kernel weight

The combined analysis of variance showed significant differences among genotypes. It is clear from (Table 3) that recommended sowing date produced significantly heavier kernels than late sowing. This result could be due to that grain-filling process was harmfully affected by high temperatures so that kernels reached dry maturity stage before complete filling. The average 1000-kernels weight of the 40 genotypes over all environments, as shown in Table (7), ranged from 32.46 for genotype No. 37 to 37.81 gm for genotype No.11 with an average of 35.22 gm over all genotypes. These results revealed that the recommended sowing date produced heavier kernels than late sowing, where the reduction was 27.31% compared with the recommended sowing.

Table 5. Means and estimated stability parameters of days to maturity of each accession (G) of wheat genotypes over all the used environments (E).

Genotype	Mean	C.V.%	bi±S.E	βi	S^2d_i	Wi
1	123.75	8.12	1.016±0.059	0.016	7.261	2.098
2	125.62	8.08	1.026±0.059	0.026	7.213	2.126
3	121.75	8.01	0.974±0.082	-0.026	13.847*	4.019
4	124.87	8.77	1.107±0.061	0.107	7.715	3.305
5	123.37	7.75	0.972±0.034	-0.028	2.531	0.798
6	124.62	8.15	1.032±0.038	0.032	3.097	0.983
7	124.37	8.44	1.040±.106	0.040	22.658**	6.626
8	123.62	7.58	0.921±0.104	-0.079	21.859**	6.840
9	123.25	8.13	1.017±0.044	0.017	4.092	1.198
10	124.50	9.10	1.144±0.066	0.144	9.064	4.590
11	126.12	8.37	1.067±0.063	0.067	8.064	2.733
12	127.87	8.21	1.056±0.073	0.056	10.839	3.398
13	125.12	8.38	1.060±0.057	0.060	6.824	2.298
14	127.50	8.25	1.054±0.083	0.054	14.103*	4.305
15	124.50	7.86	0.993±0.042	-0.007	3.752	1.076
16	127.50	6.90	0.890±0.047	-0.110	4.638	2.476
17	124.50	7.22	0.912±0.040	-0.088	3.433	1.719
18	125.62	7.59	0.960±0.064	-0.040	8.524	2.590
19	123.62	7.00	0.848±0.100	-0.152	20.509**	8.083
20	123.25	8.32	1.030±0.075	0.030	11.391	3.340
21	123.87	7.50	0.942±0.047	-0.058	4.551	1.626
22	121.87	8.93	1.108±0.030	0.108*	2.023	1.698
23	123.00	7.73	0.953±0.073	-0.047	10.902	3.326
24	125.00	8.49	1.069±0.070	0.069	10.172	3.362
25	124.12	8.18	1.030±0.045	0.030	4.195	1.283
26	122.00	7.08	0.874±0.047	-0.126*	4.671	2.869
27	124.87	8.04	1.019±0.042	0.019	3.800	1.119
28	126.25	8.21	1.047±0.060	0.047	7.396	2.326
29	125.37	7.61	0.963±0.059	-0.037	7.264	2.205
30	123.25	7.95	0.991±0.052	-0.009	5.618	1.612
31	122.50	8.03	0.994±0.058	-0.006	6.882	1.969
32	123.12	7.35	0.906±0.072	-0.094	10.542	3.855
33	122.25	7.46	0.905±0.088	-0.095	15.816*	5.390
34	125.37	7.46	0.933±0.082	-0.067	13.604*	4.319
35	122.25	7.81	0.973±0.011	-0.027	0.431	0.190
36	122.87	7.90	0.987±0.030	-0.013	2.038	0.598
37	123.87	8.42	1.059±0.042	0.059	3.804	1.419
38	125.75	8.60	1.078±0.097	0.078	19.050**	6.033
39	126.62	7.90	1.005±0.071	0.005	10.408	2.976
40	123.87	8.37	1.043± 0.074	0.043	11.257	3.390
Grand mean	124.33					
$LSD_{0.05}$	1.424					

$r(\bar{X}, bi) = 0.258$

*, ** Significantly different from unity for (bi) and from zero for (S^2d_i) at 0.05 and 0.01 probability levels, respectively.

Table 6. Means and estimated stability parameters of number of kernels/spike of each accession (G) of wheat genotypes over all the used environments (E).

Genotype	Mean	C.V.%	bi±S.E	βi	S^2d_{ii}	Wi
1	50.30	26.63	1.099±0.265	0.099	162.439**	47.482
2	46.96	21.18	0.908±0.110	-0.092	28.181*	8.986
3	48.97	21.00	0.962±0.075	-0.038	13.209	3.937
4	46.22	23.60	0.951±0.170	-0.049	67.485**	19.545
5	51.84	19.85	0.887±0.170	-0.113	66.911**	20.521
6	48.83	19.79	0.805±0.182	-0.195	76.827**	26.146
7	46.05	32.57	1.377±0.155	0.377	55.892**	31.641
8	49.61	22.21	1.013±0.111	0.013	28.693*	8.216
9	48.69	29.07	1.167±0.276	0.167	176.031**	53.353
10	48.64	14.75	0.656±0.077	-0.344**	13.939	17.001
11	49.85	16.49	0.739±0.105	-0.261*	25.687*	14.837
12	49.25	24.42	1.071±0.165	0.071	63.410**	18.678
13	50.72	24.20	1.128±0.124	0.128	35.809**	12.051
14	50.58	22.45	1.016±0.151	0.016	52.665**	15.076
15	46.76	19.14	0.830±0.079	-0.170	14.592	7.353
16	49.22	24.89	1.130±0.118	0.130	32.399**	11.122
17	50.80	23.65	1.074±0.161	0.074	60.151**	17.790
18	50.32	26.44	1.249±0.086	0.249*	17.436	11.836
19	50.24	25.32	1.200±0.068	0.200*	10.753	7.478
20	48.27	19.22	0.668±0.236	-0.332	129.211**	49.098
21	49.54	24.78	1.014±0.237	0.014	130.686**	37.360
22	48.23	27.20	1.217±0.115	0.217	30.888**	14.014
23	49.79	23.97	1.102±0.113	0.102	29.648**	9.620
24	47.53	23.99	0.954±0.212	-0.046	103.861**	29.907
25	53.10	23.23	1.150±0.099	0.150	22.702*	8.952
26	48.12	19.70	0.803±0.168	-0.197	65.497**	22.978
27	48.51	29.20	1.305±0.139	0.305	45.056**	23.136
28	51.20	24.02	1.145±0.100	0.145	23.495*	9.029
29	48.08	16.62	0.721±0.098	-0.279*	22.548*	14.995
30	50.67	26.56	1.240±0.131	0.240	40.178**	17.837
31	46.93	18.06	0.761±0.110	-0.239	28.172*	14.357
32	49.32	22.43	1.038±0.073	0.038	12.619	3.763
33	47.92	24.95	1.078±0.150	0.078	52.063**	15.543
34	49.17	22.74	0.950±0.197	-0.050	89.587**	25.875
35	45.72	14.31	0.579±0.093	-0.421**	20.358	25.331
36	48.43	19.41	0.849±0.116	-0.151	31.366**	11.484
37	53.12	22.31	1.090±0.119	0.090	32.982**	10.316
38	49.69	27.15	1.205±0.181	0.205	76.372**	26.468
39	47.18	25.98	1.125±0.127	0.125	37.775**	12.505
40	43.65	20.25	0.743±0.161	-0.257	60.123**	24.437
Grand mean	48.95					
$LSD_{0.05}$	1.816					

$r(\bar{x}, bi) = 0.387^*$

*, ** Significantly different from unity for (bi) and from zero for (S^2d_i) at 0.05 and 0.01 probability levels, respectively.

Table 7.Means and estimated stability parameters of 1000-kernel weight (g) of each accession (G) of wheat genotypes over all the used environments (E).

Genotype	Mean	C.V.%	bi±S.E	B_i	S^2d_i	Wi
1	36.83	23.98	1.269±0.220	0.269	41.776**	14.906
2	36.32	19.55	1.042±0.154	0.042	20.534**	5.938
3	34.51	16.15	0.856±0.061	-0.144	3.370	1.810
4	36.41	17.79	1.004±0.046	0.004	2.026	0.579
5	33.99	16.70	0.879±0.045	-0.121*	1.911	1.151
6	37.16	17.71	0.997±0.099	-0.003	8.585**	2.453
7	36.41	19.07	1.036±0.130	0.036	14.751**	4.266
8	33.02	16.40	0.767±0.144	-0.233	18.145**	7.409
9	34.16	18.88	0.975±0.101	-0.025	9.027**	2.604
10	34.28	17.60	0.898±0.115	-0.102	11.573**	3.731
11	37.80	18.88	1.071±0.124	0.071	13.467**	4.054
12	34.25	17.20	0.877±0.112	-0.123	10.919**	3.740
13	34.10	22.40	1.094±0.193	0.094	32.281**	9.588
14	33.30	18.90	0.915±0.145	-0.085	18.292**	5.521
15	37.37	19.75	1.111±0.123	0.111	13.201**	4.281
16	33.97	15.48	0.742±0.143	-0.258	17.697**	7.784
17	34.39	19.65	1.028±0.096	0.028	8.085*	2.342
18	36.58	22.91	1.281±0.108	0.281*	10.222**	6.157
19	36.12	17.75	0.983±0.074	-0.017	4.949	1.425
20	35.38	23.43	1.237±0.154	0.237	20.677**	8.223
21	34.85	18.63	0.926±0.168	-0.074	24.377**	7.188
22	37.01	17.58	0.962±0.132	-0.038	15.137**	4.383
23	36.67	19.37	1.083±0.096	0.083	8.117*	2.602
24	36.61	19.85	1.069±0.154	0.069	20.552**	6.068
25	36.26	15.83	0.856±0.107	-0.144	9.965**	3.696
26	33.53	18.66	0.940±0.107	-0.060	10.087**	3.027
27	34.24	21.17	1.093±0.118	0.093	12.214**	3.844
28	34.99	21.48	1.101±0.165	0.101	23.624**	7.170
29	34.34	19.30	0.976±.140	-0.024	17.009**	4.883
30	34.52	13.89	0.688±0.119	-0.312*	12.407**	7.536
31	34.49	17.59	0.895±0.126	-0.105	13.887**	4.421
32	35.83	17.09	0.856±0.173	-0.144	25.964**	8.268
33	32.65	17.69	0.851±0.121	-0.149	12.838**	4.583
34	36.44	23.09	1.294±0.090	0.294*	7.127*	5.596
35	34.64	18.61	0.985±0.082	-0.015	5.993	1.721
36	36.93	22.18	1.261±0.087	0.261*	6.656*	4.687
37	32.46	20.79	0.950±0.185	-0.050	29.674**	8.580
38	36.28	20.17	1.122±0.086	0.122	6.491*	2.469
39	35.53	19.08	1.036±0.091	0.036	7.304*	2.140
40	34.02	19.69	0.990±0.137	-0.010	16.244**	4.645
Grand mean	35.22					
$LSD_{0.05}$	0.952					

$r(\bar{x}, bi) = 0.559^{**}$

*, ** Significantly different from unity for (bi) and from zero for (S^2d_i) at 0.05 and 0.01 probability levels, respectively.

These results could be due to the effects of high temperatures displayed as shrinked kernels influenced grain maturity (Ismail 1995). These results are in harmony with those of Sharma and Singh (1972), Abdel-Shafi *et al* (1999) and El-Morshidy *et al* (2001).

Grain yield

The combined analysis of variance (Table 2) showed significant effect in grain yield as influenced by sowing dates, locations and genotypes evaluated. The recommended sowing date gave 5.498 compared with 3.906 t/ha produced from late sowing plants (Table 3). These results revealed that delaying sowing date strongly decreased grain yield by an average of 28.96% as compared with the recommended sowing date. These results could be attributed to the delay in heading date (late sowing). Consequently, grains were assumed to be influenced by high temperature that was prevailing during this period. Therefore, reducing number of kernels/spike combined with less 1000-kernel weight markedly reduced grain yield. This finding agrees with that obtained by Abdel-Shafi *et al* (1999) and El-Morshidy *et al* (2001). The performances of genotypes are presented in (Table 8). Results indicated that grain yield of the various genotypes ranged from 3.932 for genotype No.32 to 5.286 t/ha for genotype No. 25 with an average of 4.702 t/ha.

However, the results of all studied traits revealed that there were highly significant differences due to the environmental factors i.e., years, sowing dates and locations. In addition, the genotypes displayed different response to those environmental factors as the different degrees of interactions were mostly significant. Therefore, it is a good choice to study the stability of those genotypes over speculative eight environments aiming to understand their behavior.

Genotype-environment interaction and stability analysis

The joint regression analysis of variance (Table 9) indicated highly significant differences among genotypes for all the studied characters. Moreover, partitioning means of squares due to environments plus genotypes x environments interactions as indicated by E + (G x E) to the following items E (Linear), heterogeneity of linear responses (G x E linear) and remainder sums of squares. The results were highly significant for all the studied traits. The stability analysis could be preceded since results revealed significant genotype x environment (linear) according to Eberhart and Russell 1966. Kheiralla and Ismail (1995) found significant genotype x environment interaction respecting heading date and grain yield for ten genotypes evaluated under combinations of 20 and 80% depletion of soil available water and three doses of nitrogen.

Table 8. Means and estimated stability parameters of grain yield T/ha. of each accession (G) of wheat genotypes over all the used environments (E).

Genotype	Mean	C.V.%	bi±S.E	βi	S^2d_i	Wi
1	4.713	33.81	1.190±0.073	0.190*	0.360	0.164
2	5.115	36.48	1.400±0.061	0.400**	0.300	0.367
3	5.003	33.24	1.210±0.137	0.210	0.850*	0.318
4	5.040	32.27	1.210±0.076	0.210*	0.380	0.186
5	5.021	22.81	0.830±0.081	-0.170	0.400	0.162
6	4.467	21.56	0.690±0.080	-0.310**	0.400	0.282
7	4.988	38.11	1.410±0.109	0.410**	0.600	0.465
8	5.007	29.66	1.110±0.073	0.110	0.360	0.121
9	5.070	31.75	1.190±0.106	0.190	0.580	0.225
10	5.137	33.25	1.290±0.046	0.290**	0.240	0.210
11	5.129	32.48	1.260±0.029	0.260**	0.150	0.159
12	4.281	28.50	0.890±0.090	-0.110	0.460	0.153
13	4.978	29.69	1.120±0.048	0.120*	0.080	0.048
14	4.219	35.99	1.130±0.080	0.130	0.400	0.142
15	4.324	34.34	1.080±0.121	0.080	0.690	0.209
16	4.598	34.77	1.170±0.127	0.170	0.750	0.262
17	5.138	34.61	1.330±0.077	0.330**	0.380	0.299
18	4.332	25.68	0.790±0.104	-0.210	0.550	0.233
19	4.363	25.31	0.760±0.127	-0.240	0.750	0.309
20	4.994	25.73	0.920±0.122	-0.080	0.700	0.211
21	4.814	27.28	0.970±0.070	-0.030	0.340	0.099
22	4.060	22.87	0.570±0.157	-0.430*	1.060*	0.621
23	4.400	24.17	0.790±0.046	-0.210**	0.240	0.148
24	4.508	21.20	0.690±0.061	-0.310**	0.300	0.248
25	5.286	29.54	1.100±0.173	0.100	1.250**	0.373
26	4.805	24.37	0.880±0..011	-0.120**	0.160	0.072
27	4.667	34.46	1.170±0.138	0.170	0.850*	0.291
28	4.509	31.56	0.990±0.167	-0.010	1.180**	0.336
29	4.879	25.82	0.950±0.033	-0.050	0.130	0.040
30	4.293	25.36	0.687±0.178	-0.313	1.308**	0.542
31	4.801	28.96	1.041±0.045	0.041	0.241	0.071
32	3.932	25.77	0.645±0.159	-0.355	1.084*	0.526
33	4.870	30.90	1.127±0.056	0.127	0.282	0.108
34	4.714	26.96	0.888±0.143	-0.112	0.909*	0.281
35	4.159	10.00	0.286±0.039	-0.714**	0.112	0.908
36	4.807	37.03	1.329±0.090	0.329*	0.456	0.316
37	4.769	29.39	1.044±0.064	0.044	0.315	0.093
38	4.772	29.20	1.025±0.091	0.025	0.466	0.134
39	4.510	23.35	0.758±0.084	-0.242*	0.419	0.220
40	4.606	30.89	1.078±0.048	0.078	0.083	0.034
Grand mean	4.702					
$LSD_{0.05}$	0.356					

$r(\bar{X}, bi) = 0.710$**

*, ** Significantly different from unity for (bi) and from zero for (S^2d_i) at 0.05 and 0.01 probability levels, respectively.

Table 9. Combined analysis for agronomic characters of forty bread wheat genotypes based on eight environments according to Eberhart and Russell technique.

Source of variance	d.f	Mean Square (M.S.) variance for all studied characters				
		Days to heading (HD)	Days to maturity(MD)	No. of kernels/spike	1000-kernels weight gm	Grain yield (T/ha)
Genotypes (G)	39	91.575 **	59.138 **	89.426**	47.669**	2.780 **
E+G x E	280	173.776 **	296.64 **	387.832**	137.808**	5.913**
a-E (linear)	1	44931.366**	80620.35 **	92631.492**	34481.022**	1445.370**
b-G X E linear	39	9.958 **	9.356 *	88.087**	18.010**	2.221**
c- Pooled dev.	240	13.907 **	8.646 **	52.192**	14.179**	0.514**
Pooled error	624	3.477	6.335	10.170	2.913	0.399

*, ** are significant at 0.05 and 0.01 probability levels, respectively.

The main objective of plant breeders in breeding programs is to select genotypes that have both high average performance and most stable across various environments. Our data in Tables (4 through 8) suggest that it is possible to select among wheat genotypes in the course of the present investigation depending on combinations of genotypes performance and stable production over environments. Therefore, in this research a genotype will be selected if it has; higher mean performance than the grand mean, lesser (mild) C.V%, less ecovalence W_i, $b_i > 1.0$ and smaller $S^2 d_i$.

Adaptability

According to Eberhart and Russell (1966) the mean performance with the regression coefficient values and deviation from regression provide useful parameters for identify the adapted genotypes. Finlay and Wilkinson (1963), also, in their interpretation for the analysis of adaptation in plant breeding programs, reported that regression coefficient approximating to 1.0 indicated average stability. When average stability associated with high average yield over all environments, genotypes may be described as having general adaptability and vice versa. Moreover, (b_i) values significantly more than unit 1.0 identify genotypes benefit response to more inputs while genotypes have (b_i) values significantly less than 1.0 don't response to more inputs of favorable environmental factors. Also, the test of significance of each ($S^2 d_i$) for values differed from zero indicates that the genotype in question has specific adaptability.

The high C.V% indicates the high influence of the environmental conditions and GE effects on the performance of the genotypes for the studied traits, but this parameter is not a purely estimate of the genotype-environment interaction as basically affected by genotype mean and environmental variation.

The ecovalence (W_i) estimate was postulated by Wricke (1962), it is calculated from the effect of genotype environment interaction. Comparing with Eberhart and Russell (1966) estimates (b_i and S^2d_i), the ecovalence depends on the whole effect while either b_i or S^2d_i depend on partitioning the interaction effect to a part linearly respond to environmental changes and part represent the deviation form the linear response. Therefore, a genotype displays high performance and very small W_i value can be selected even it has b_i significantly access unity, since it will has benefit response to environmental changes. Thus, the distribution pattern of studied genotypes according to their performances and ecovalence estimates is presented graphically to identify best genotypes (Fig1).El-Menshawi (2005) used ecovalence to evaluate grain sorghum hybrids over eight environments.

Days to 50% heading:

The stability parameters (C.V%, b_i, S^2d_i and W_i) and the mean performance ($\overline{X}$) of the individual genotypes are presented in Table (4). The regression coefficients (b_i) for genotypes No. 13, 17, 19, 22, 23, 25, 26, 27, 28, 30, 31, 32, 33, 35 and 39 were statistically equal unity and the deviations from regression (S^2d_i) of those genotypes were also non-significantly differ from zero, indicating that these genotypes may be considered as stable for such trait. These genotypes showed moderately low C.V% due to GE .Six of these fifteen genotypes were the most stable genotype according to ecovalence estimates. These genotypes are No. 19, 33, 13, 35, 23 and 17, respectively. The genotypes No. 17, 19, 22, 30, 32, 33 and 35 were taken into consideration because they were early in heading than the average over all genotypes besides their stability (Fig.1). These genotypes might have genetic systems controlling earliness and able to work consistently over environments.

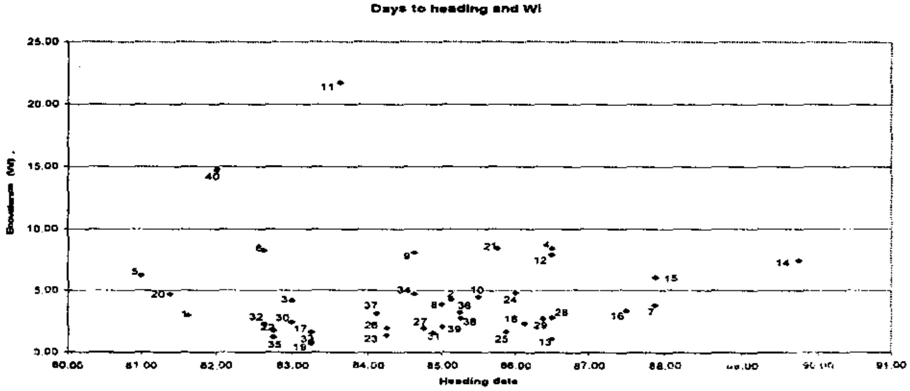

Figure 1. The distribution pattern of genotypes according to their heading date (X-axis) and their W_i estimates (Y-axis).

The correlation coefficient between $\overline{X}$ and b_i was positive and highly significant (r=0.411**) confirming that the late genotypes in heading had high values of b_i (Table 4). Similar results were obtained by Jatasra and Paroda (1979). In this respect, Salem *et al* (1990) found negative and highly significant values between $\overline{X}$ and b_i.

Days to Physiological maturity

The stability parameters (C.V%, b_i, S^2d_i and W_i) of the individual genotypes are presented in Table (5). All genotypes were proved to be stable as they had b_i values that did not significantly differ from the unity and S^2d_i estimates also did not significantly differ from zero, except genotypes No. 3, 7, 8, 14, 19, 22, 26, 33, 34 and 38 that exhibited higher W_i values and C.V%. The highest S^2d_i values for unstable genotypes indicated a specific instability for such trait. It is concluded that the genotypes No. 31, 35, 36 and 37 were the most desired genotypes with respect to this character, since they were earlier in maturity when compared with the average over all genotypes beside their good stability (Fig.2). In addition, the genotype No. 22 showed earlier maturity while it showed positive and significant βi value indicating its response toward latting maturity in hot weather leading to earlier maturing, it showed low W_i value.

The results showed positive correlation between mean performance and b_i (r=0.258) which indicate that late mature genotypes have positive (b_i) values (Table 5). Similar results were obtained by El-Morshidy *et al* (2001).

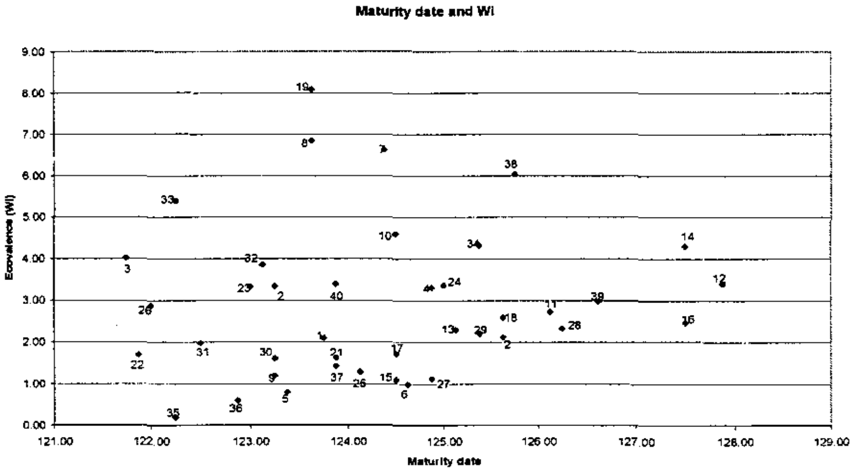

Figure 2. The distribution pattern of genotypes according to their maturity date (X-axis) and their W_i estimates (Y-axis).

Number of kernels/ spike

The stability parameters (C.V%, b_i, S^2d_i and W_i) as well as the mean performance of individual genotypes are shown in Table (6). Regarding number of kernels/spike, results indicated that all genotypes were considered unstable except genotypes No. 3, 15, 18, 19 and 32. Among these genotypes two genotypes (18 and 19) had significant βi values that they positively responded to more favorable conditions. But they had moderately low W_i values. The (b_i) values for all genotypes were insignificantly different from unity and had suggesting that they did not consistently respond to environmental changes, except genotypes denoted No. 10, 11, 29 and 35, which gave significantly negative values meaning that they were adapted to bad condition resulted from late sowing. Similar finding were obtained by Kheiralla *et al* (1997) and El-Morshidy *et al* (2001). The high deviations from regression (S^2d_i) values for unstable genotypes indicated a specific instability for this trait.

The positive and significant correlation (r= 0.387*) between mean performance ($\bar{X}$) and regression coefficient (b_i) for such trait revealed that the studied genotypes showed good performance associated with the linear response to environmental changes (Table 6). These results are in line with those obtained by Jatasra and Paroda (1979), Salem *et al* (1990) and El-Morshidy *et al* (2001).

However, Figure (3) illustrate the genotypes distribution according to their performance and their ecovalence estimates, which revealed that genotypes No. 25 and 37 gave the highest kernel number/spike and low W_i values although they had significant S^2d_i values.

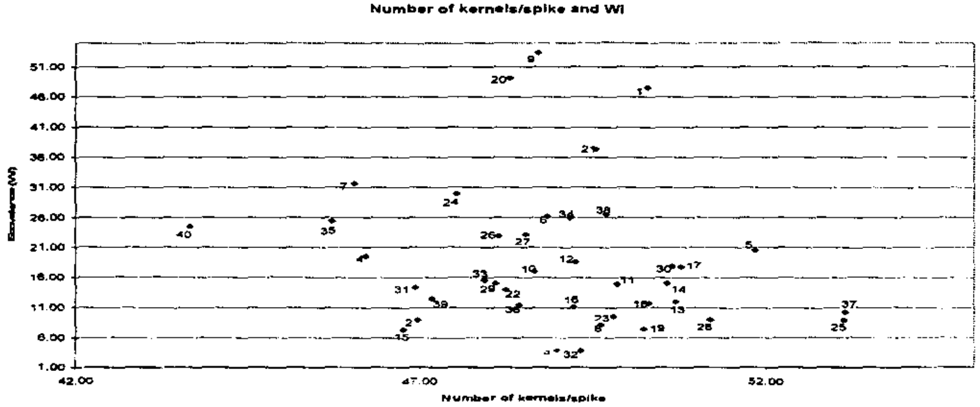

Figure 3. The distribution pattern of genotypes according to their number of kernels/spike (X-axis) and their W_i estimates (Y-axis).

1000-Kernel weight

The studied accessions considerably differed in their average of 1000-kernel weight which ranged from 32.46 for genotype No.37 to 37.81 g for genotype No.11 with an average of 35.22 g over all genotypes (Table 7). Four genotypes among the 40 genotypes had satisfied selection criteria to be defined as the most stable suitable genotypes according to Eberhart and Russell (1966) with respect to the present character.

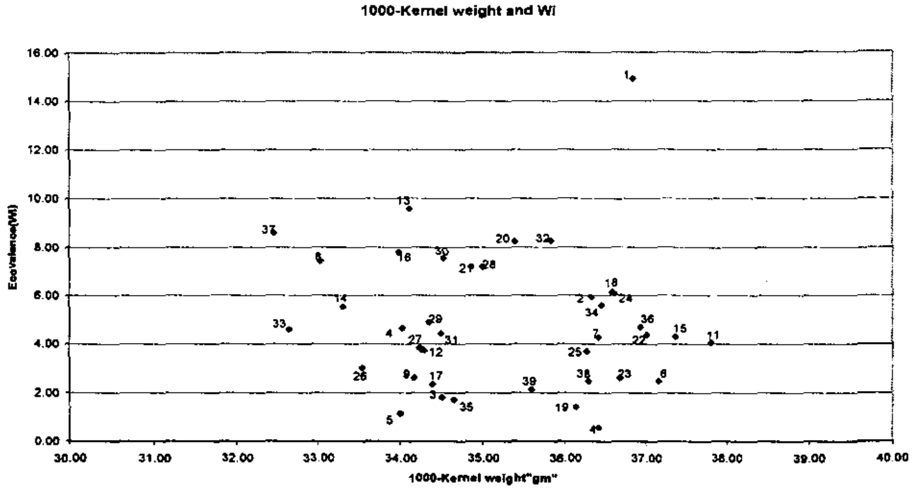

Figure 4. The distribution pattern of genotypes according to their 1000- kernel weight (X-axis) and their W_i estimates (Y-axis).

These genotypes numbers 3, 4, 19 and 35 were characterized by having low C.V.% and b_i and $S^2 d_i$ did not significantly differ from a unit and zero, respectively. In the same time, these genotypes displayed the lowest W_i values (Fig. 4). Fortunately, the genotypes (4 & 19) have an average above the grand mean, whereas each of the other two genotypes (3 & 35) has an average below the grand mean.

The results showed positive and highly significant correlation (r= 0.559**) between mean performance ($\bar{X}$) and regression coefficient (b_i) for 1000- kernel weight revealing that the linear response to environmental improvements cause high average 1000-kernel weight over all environments. Similar results were obtained by Salem *et al.* (1990) and Kheiralla *et al.* (2004).

Grain yield

The stability parameters (Table 8) revealed that the regression coefficient (b_i) values of the forty genotypes in this study ranged from 0.286 to 1.410. The significant variation in (b_i) values suggested that the genotypes responded differently to studied environments (Sharma *et al* 1987, Kheiralla *et al*1997 and El-Morshidy *et al*2001). Variability among environments is an important factor and in large part determines the usefulness of (b_i) values (Pfahler and Linskens 1979). A large part of variability estimates of (b_i) values among genotypes lead to highly significant varied linear responses, a similar finding was obtained by Kheiralla *et al* (1997).

The results showed that genotypes No.5, 8, 9, 12, 14, 15, 16, 18, 19, check variety No.20 (Giza 168), 21, 29, 31, 33, 37, 38, and check variety No.40 (Sakha 93) were stable (b_i and S^2d_i values did not significantly differ from one and zero, respectively). Among these genotypes, five entries displayed least W_i values. Those were No. 21, 29, 31, 37 and 40 (Sakha93). The genotypes No. 5, 8, 9 and 20 could be considered the best, since it had grain yield more than the average genotypes besides their stable behavior (Fig., 5).The correlation between the mean grain yield ($\bar{X}$) and the regression coefficient (b_i) was significantly positive (r=0.710**) indicating that genotypes tended to linearly response to changes in the environment so that high yielding had significantly positive βi values whereas the less yielding genotypes had significantly negative βi values. Results on the same line were recorded by Salem *et al* (1990), Ismail (1995), El-Morshidy *et al*(2001) and Kheiralla *et al* (2004).

However, two genotypes attracted the attention to their behavior across studied environments. They were No. 19 and 37. The former genotype (19) was detected as superior one according to its performances and stability of days to 50% heading, number of kernel/spike and 1000-kernel weight, and in the same time it was stable having insignificant βi and S^2d_i values but unfortunately it had average grain yield less than the grand mean over all genotypes and all environments. The latter genotype (37) was also detected as superior one according to its performances and stability of days to maturity and number of kernels/spike. In addition, it displayed high stability for grain yield with three measurement βi, S^2d_i and W_i and had average grain yield exceeded the grand mean. Nevertheless, the difference between these two genotypes was the βi values, they were negative (-0.210) and positive (0.044) for genotypes No. 19 and 37, respectively. This case concerts with the significant positive correlations between performance and

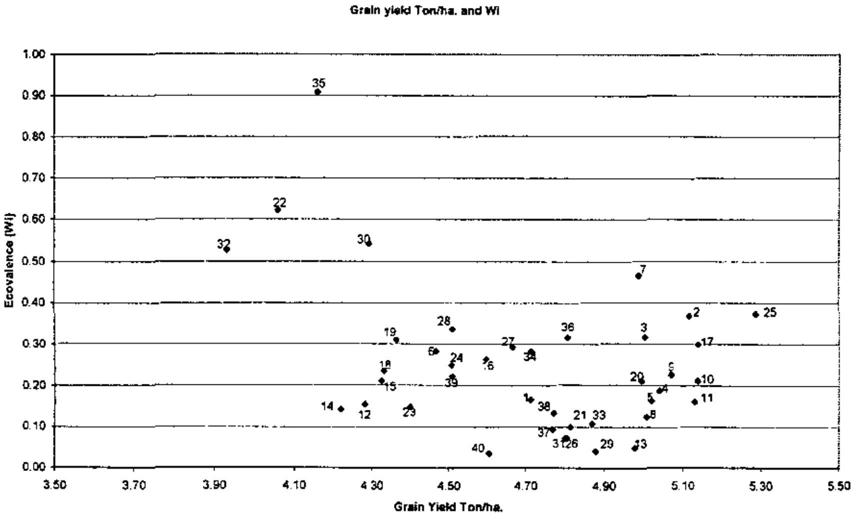

Figure 5. The distribution pattern of genotypes according to their grain yield (X-axis) and their W_i estimates (Y-axis).

βi value to suggest the selection for significant positive βi values with high performance on one side and the lowest W_i values with insignificant S^2d_i value on the other side. This suggestion is correct if there is a speculative genotype displaying the best performance over all environments.

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قياسات الثبات لبعض التراكيب الوراثية لقمح الخبز في الأراضي القديمة والجديدة تحت ظروف بيئية مختلفة فى مصر العليا

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يعتبر تقدير التفاعل بين التراكيب الوراثية والعوامل البيئية من أهم أهداف مربي النبات فيجب أن يأخذ في الاعتبار وتقييم الأصناف في البيئات المختلفة درجة معنوية هذا التفاعل. ويهدف هذا البحث إلي تقدير هذا التفاعل ثم دراسة معالم الثبات و الأقلمة لمقارنة أربعون تركيباً وراثياً من قمح الخبز من مصادر مختلفة لتحمل الحرارة في ثمانية بيئات (موسمين في ميعادين زراعة في موقعين هما أسيوط وكوم أمبو) خلال موسمين متتاليين. وقد تم دراسة عدد الأيام من الزراعة حتى التزهير والنضج، عدد حبوب السنبلة، وزن الألف حبة، ومحصول الحبوب طن/هكتار. وقد أظهرت النتائج استجابات مختلفة للتراكيب الوراثية من بيئة إلي أخري. كما أدت الزراعة في ميعاد متأخر إلي نقص في عدد الأيام من الزراعة إلي التزهير، ميعاد النضج الفسيولوجي وعدد الحبوب في السنبلة، وزن الألف حبة ومحصول

الحبوب بمقدار ١٣,٦٥، ١٣,٤٧، ٢٥,٧٧، ٢٧,٣١، ٢٨,٦٩ علي الترتيب بالمقارنة بالزراعة في الميعاد الموصي به.

أظهر تحليل تباين الانحدار فروقا عالية المعنوية بين التراكيب الوراثية، البيئات، التفاعل الوراثي البيئي لكل الصفات تحت الدراسة.وقد أوضح تقسيم مجموع مربعات التفاعل الوراثي البيئي أن مجموع مربعات عدم التجانس عالي المعنوية لكل الصفات تحت الدراسة. وكان مجموع مربعات القيم المتبقية أيضا عالي المعنوية وهذا يشير إلي وجود المكون غير الخطي للتفاعل الوراثي البيئي. كان معامل الارتداد مرتبطاً ارتباطاً ايجابياً مع متوسط الأداء وهذا يوضح أن التراكيب الوراثية عالية المحصول تكون متلازمة مع معامل الانحدار الوراثي وتستجيب للبيئات المختلفة. ومع ذلك أظهرت التراكيب الوراثية أرقام (٥، ٨، ٩ و٢٠) ثبات وارتفاع المحصول.

أكدت النتائج ضرورة استخدام كل من متوسط أداء التركيب الوراثي ومقياس الثبات الخاصة به معا للتوصية باستخدام أي تركيب وراثي في بيئات مختلفة.

وقد وجد أن التراكيب الوراثية الثابتة والمتفوقة في متوسط الأداء بمقارنتها بالمتوسط العام تحت كل البيئات تشمل (٥ ،٨ ، ٩، ٢٠) لمحصول الحبوب. وهذه التراكيب الوراثية يمكن استخدامها في برامج التربية لأنها ذات قدرة محصولية عالية وعلي درجة عالية من الثبات.