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GENETIC STABILITY AND DIVERSITY IN YIELD COMPONENTS OF SOME WHEAT GENOTYPES THROUGH SEASONS AND HEAT STRESS UNDER DIFFERENT LOCATIONS

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ABSTRACT

Genetic stability and diversity are two of the key factors for the improvement of many crop plants. A major challenge for plant breeders is selection of high yielding genotype with wide adaptation. Therefore, thirty six wheat genotypes were evaluated under two locations (Sohag and Aswan, Egypt) on favorable and late sowing date during winter seasons of 2012/2013 and 2013/2014 to estimate its performance and stability parameters. The wide range of weather conditions resulted in a broad variation of mean yields, ranging from 6.59 t/ha in favorable sowing date to 4.99 t/ha in late sowing date as heat stress. The combined analysis of variance showed that the flag leaf area, days to heading, spike length, 1000-kernel weight and grain yield were significantly influenced by years, locations, sowing dates and genotypes. Mean environmental grain yield ranged from 2.70 t/ha to 9.27 t/ha. The results showed that sowing at the favorable date increased all studied traits. The 36 genotypes showed diversity for the slopes of the joint regression. Genotypes No. 5, 6, 14, 19, 20, 22, 24 and 32 exhibited stability for grain yield and useful in the breeding program in developing new wheat genotypes with tolerance to heat stress conditions. Positive correlation was found between b_i and $\overline{x}$ for days to heading, spike length, number of kernels/spike, 1000-kernel weight and grain yield (0.89**, 0.50**, 0.07, 0.13 and 0.51**), respectively. This might be due to adaptation of these genotypes to wide differences in climatic conditions which prevailed at the two studied locations. The best genotypes in terms of both favorable and heat stress indicating that selecting for improved yield potential may increase yield in wide range of environments.

Keywords: wheat (*Triticum aestivum* L.), genotypes, stability, locations, sowing date, years.

INTRODUCTION

Increasing in crop yields are important to ensure food supply for humanity (Rondanini *et al.* 2012). Terminal heat is a major abiotic stress affecting yield in wheat. Under heat stress, the photosynthetic process is affected especially during grain filling stage when demand for assimilates is the greatest (Kumari *et al.* 2007). Stay-green character is an important trait that allows plants to retain their leaves in active photosynthetic under stress conditions (Rosenow *et al.* 1983). In the rice-wheat cropping system, crop damage due to heat stress under late planting conditions has become an important factor limiting wheat yields (Aslam *et al.* 1989). High temperatures during early crop development and particularly after anthesis may limit yield (Hunt *et al.* 1991). Temperature fluctuations during grain filling were found to cause deviations from expected dough properties (Blumenthal *et al.* 1991). The rise in daily average temperature, up to about 30 ºC, increased dough strength, while temperatures above this threshold value (35 - 40 ºC), even for periods of only few days, tended to decrease dough strength (Randall and Moss 1990; Corbellini *et al.* 1997). Mondal *et al.* (2013) suggested that the early maturing, high yielding, and heat tolerant wheat lines developed in Mexico can adapt to the diverse heat stressed area. The phenotypic performance of a genotype is not necessarily the same under diverse agro-ecological conditions (Ali *et al.* 2003). Genotype-environment (GE) interactions are extremely important in the development and evaluation of genotypes because it reduce the genotypic stability values under diverse environments (Hebert *et al.* 1995).

The concept of stability was defined in several ways and several biometrical methods including univariate and multivariate ones (Crossa 1990). The most widely used method is the regression way, which is based on regressing the mean value of each genotype on the environmental index or marginal means of environments (Tesemma *et al.* 1998). A good method for measuring stability was previously proposed (Finlay and Wilkinson 1963) and was later improved (Eberhart and Russell 1966). The stable variety was defined by a high mean yield, regression coefficient (b_i = 1.0) and the deviations from regression as small as possible (S^2d_i = 0). In addition, the stability was defined as adaptation of varieties to unpredictable and transient environmental conditions and the technique has been used to select stable genotypes unaffected by environmental changes (Allard and Bradshaw 1964).

Musich and Dusek (1980) found a decrease in grain yield by delaying sowing date. Dessouki *et al.* (1974) reported that the optimum date of wheat sowing was mid-November in Lower Egypt and 10 days later in Upper Egypt. Spring wheat grain yield and its components were reported to be more closely associated with temperature variation according to locations than with variation in transpiration (Saadalla 1993).

Therefore, the objective of this study is to estimate the stability parameters of thirty six wheat genotypes under six environments (two sowing dates, two locations and two years) for selecting widely adapted genotypes.

MATERIALS AND METHODS

Planting and treatments:

Thirty six wheat genotypes were evaluated for its performance and stability parameters in the field under normal irrigated conditions. A set of 36 bread wheat genotypes (Table 1) were classified as: No.1 to No.34 genotypes were obtained from the International Maize and Wheat Improvement Center (CIMMYT), MEXICO, and Sides 12 (No.35) and Egypt 1 (No.36) from Egypt. The experimental design was a randomized complete block design with three replicates and the treatments were arrangement in a split-plot. The sowing dates and genotypes were randomly assigned to the main plot and sub-plot, respectively. Each genotype was sown in a plot of 10.5 m^2 area. Wheat genotypes were sown in the field at two dates, 15 November (favorable) and 28 December (heat stress), during winter season of 2012/2013 and 2013/2014.

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The first location was carried out at the Experimental Farm, Faculty of Agriculture, Sohag University, Sohag, Egypt, which located about 600 kilometres from the second location of the Experimental Farm, Field Crops Research Institute, ARC, Aswan, Egypt. The mean daily maximum and minimum temperatures from the time of sowing date to harvest at the two locations are given in Table 2.

Table 2: Means of the maximum and minimum air temperatures (ºC*), during wheat growth stages in favorable and late sowing at Sohag and Aswan locations.

Locations	Months	Years			
		2012/2013		2013/2014	
		Max.	Min.	Max.	Min.
Sohag	November	22.03	8.57	29.23	13.52
Aswan		27.00	8.40	30.00	11.4
Sohag	December	21.37	7.55	24.41	10.18
Aswan		24.70	6.1	24.80	7.9
Sohag	January	18.93	4.22	19.05	7.51
Aswan		21.50	3.00	25.50	6.3
Sohag	February	20.81	7.09	27.64	9.42
Aswan		26.80	9.00	28.00	8.3
Sohag	Mars	23.20	8.00	28.02	10.83
Aswan		28.80	9.90	32.20	12.8
Sohag	April	33.49	20.53	31.58	15.75
Aswan		36.6	16.40	33.90	14.6
Sohag	May	36.00	25.60	39.55	26.41
Aswan		35.20	17.6	39.80	20.40

***Egyptian Meteorological Authority.**

Traits measured*:*

Data of flag leaf area (leaf length x width x 0.75) was measured according to Jatimliansky and Babinec (1984). Days to heading recorded by the number of days elapsed from sowing until the upper most spikes appeared beyond the auricles of the flag leaf sheath (50% heading). Spike length was recorded in (cm) for mean of ten main spikes/plot. The number of kernels/spike and weight of 1000-kernel were recorded. Grain yield (ton/ht.) from each replication 10.5 m^2 area was harvested to calculate grain yield.

Statistical analysis:

The combined analysis of variance was performed according to Gomez and Gomez (1984). The stability analysis was, however, computed as outlined by Eberhart and Russell (1966). Data analysis for genotypes, revised least significant difference (LSD’) between genotypes and the interaction among genotypes and other factors were calculated. The analyses of variance were computed using MSTATC microcomputer program (MSTATC 1990). The stability parameters for all studied traits using SPSS (version 10) program were used to develop graphical illustration (SPPS 1995).

RESULTS AND DISCUSSIONS

Environments effect:

Results indicated that, the wide range of weather conditions resulted in a broad variation of mean yields, ranging from 6.59 t/ha in favorable sowing date to 4.99 t/ha in late sowing date as heat stress (Table 3). Sowing dates of the trial varied within each environment and may have had an impact on grain yield. The locations with a later sowing date were exposed to higher temperature stress early in the crop season, which may have affected crop growth and final grain yield. Sohag and Aswan locations differed by 0.30 in mean grain yield. Mondal *et al.* (2013) found, every 1°C rise in temperature there was a 7–8% loss in grain yield. Based on the study results, we are in agreement with Aggarwal *et al.* (2010) and Lobell *et al.* (2008), they reported yield losses of 6–20% for South Asia and the Eastern Gangetic wheat growing regions by various simulation studies.

Table 3: Means of traits for the thirty six genotypes over years, sowing dates and locations.

Item	Days to heading	Flag leaf area	Spike length	Number of kernels/spike	1000-kernel weight	Grain yield
First year	87.43	23.01	11.54	47.51	45.95	5.88
Second year	85.28	22.64	11.14	46.53	44.54	5.70
Favorable sowing date	94.05	24.40	12.17	51.70	52.10	6.59
Late sowing date	78.66	21.25	10.51	42.33	38.40	4.99
Sohag location	87.29	23.44	11.64	48.55	48.99	5.89
Aswan location	85.42	22.21	11.04	45.49	41.50	5.69
Mean overall	86.36	22.83	11.34	47.02	45.25	5.79

Late sowing date during crop growth and development at Sohag location, resulted in a 5.89 t/ha higher mean grain yield than at Aswan location which produced 5.69 t/ha (Table 3). In the two locations, temperatures were relatively warmer during crop growth and grain filling stage, which not only had an impact on grain yield but also on days to heading traits. A reduction in flag leaf area, days to heading, spike length, number of kernels/spike, 1000-kernel weight and grain yield were observed under the high temperatures of Aswan location (Table 2). Continuous warm temperatures decreased the mean of days to heading at Sohag and Aswan locations by 15.61 and 15.18 days, respectively compared to favorable sowing date (Table 5). Previous studies have reported similar effects of high temperature stress on days to heading (Yang *et al.* 2002, Mason *et al.* 2010 and Mondal *et al.* 2013). Mondal *et al.* (2013) reported that the locations with a later sowing date were exposed to higher temperature stress early in the crop season, which may have affected crop growth and final grain yield.

The grain yield differed through years which ranged from 5.88 t/ha in 2012/2013 to 5.70 t/ha in 2013/2014 (Table 3). This due to the high temperatures input during grain filling period in 2013/2014, whereas wheat production is often limited by terminal heat stress. The results in Table 2 showed wide fluctuations of the temperature over the growing seasons.

Temperatures at different growing stages of the same sowing date were not fixed in the two seasons of the study. Moreover, the temperature of growing months fluctuated from season to another season and from location to another location. The results showed that grain yield was decreased about 24.28% under late sowing date (Table 3). Rosenzweig and Tubiello (1996) reported that consistent decreases in wheat yield due to daily temperature rise. Li *et al.* (2014) demonstrated that yield potential varied greatly across locations.

Interactions effect:

The combined analysis of variance revealed that the interactions between genotypes (G), sowing dates (D), years (Y) and locations (L) for all studied traits were highly significant (Table 4). The differences between the Y*L, Y*D, L*D, Y*L*D, Y*G, L*G, Y*L*G, D*G and Y*D*G were highly significant were observed for all studied traits. Highly significant differences between the L*D*G for all studied traits, except days to heading and flag leaf area, while differences between the Y*L*D*G were significant for all studied traits except days to heading and spike length. These results indicated that the studied genotypes responded differently to the different environmental conditions suggesting the importance of the assessment of genotypes under different environments in order to identify the best genetic make up for a particular environment. El-Morshidy *et al.* (2001) and Tawfelis (2006) found significant variation in yield and yield components among wheat genotypes under favorable and late planting. Hamam and Khaled (2009) and El Ameen (2012) showed highly significant differences between genotypes as well as (genotypes x environment) for flag leaf area, days to heading, spike length, number of kernels/spike, 1000-kernel weight and grain yield.

Table 4: The combined analyses of variance over years (Y), locations (L), sowing dates (D) and genotypes (G) for studied all traits.

Source of variation	d.f	Flag leaf area	Days to heading	Flag leaf area	Spike length	Number of kernels/spike	1000-kernel weight	Grain yield
Year (Y)	١	326.98**	50.57**	326.98**	8.86**	221.4**	121.691**	8.51**
Location (L)	1	28.96**	998.18**	28.96**	33.47**	206.6**	427.84**	7.64**
Y*L	1	134.41**	998.18**	134.41**	6.95**	431.42**	218.76**	7.64**
Error (a)	8	3.39	24.03	3.39	3.43	7.32	7.24	4.54
Sowing dates (D)	1	213.81**	512.85**	213.81**	589.55**	189.59**	205.56**	353.18**
Y*D	1	118.90**	54.34**	118.90**	18.67**	1661.48**	1179.43**	19.93**
L*D	1	0.29**	9.76**	0.29**	0.20**	3.85**	10.93**	0.14**
Y*L*D	1	0.76**	9.76**	0.76**	0.07**	5.89**	6.25**	0.14**
Genotypes (G)	35	335.7**	121.34**	335.7**	44.01**	1598.37**	1090.15**	57.9**
Y*G	35	1.11**	54.66**	1.11**	0.14**	15.06**	15.43**	4.9**
L*G	35	0.02**	0.049**	0.02**	0.013**	0.15**	0.24**	0.124**
Y*L*G	35	0.10**	0.049**	0.10**	0.002**	0.34**	0.11**	0.124**
D*G	35	6.16**	5.04**	6.16**	0.034**	37.84**	40.99**	2.59**
Y*D*G	35	0.86**	0.26**	0.86**	0.13**	34.57**	7.74**	1.02**
L*D*G	35	0.001	0.0001	0.001	0.001	0.02**	0.014**	0.004**
Y*L*D*G	35	0.002*	0.0001	0.002*	0.001	0.021**	0.01**	0.004**
Error (b)	568	0.002	0.004	0.002	0.0001	0.005	0.005	0.0002

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

Performance of genotypes:

Sowing at the favorable date (November) increased all studied traits (Table 3). Flag leaf area, days to heading, spike length, number of kernels/spike, 1000-kernel weight and grain yield traits were increased under Sohag location. The results revealed that wheat genotypes responded differently when they were grown at different seasons.

The flag leaf area:

The average of flag leaf area ranged from 14.07 to 29.41 cm for genotypes No. 2 and 6, respectively with an overall average of 22.83 cm. Flag leaf area decreased (12.89%) by delaying in sowing date (Table 5). When growth resources are limited by heat stress, the size of plant organs such as leaves, tillers, and spikes is reduced (Fischer 1984). Hamam and Khaled (2009) found, flag leaf area decreased (13.29%) by delaying in sowing date.

Days to heading:

The average of number of days to heading in late sowing date was reduced by 15.4 days. The mean number of days to heading of the different genotypes ranged from 80.08 (Genotype No. 25) to 93.23 (Genotype No. 33) days, with an overall average 86.36 days. The earliest genotypes were No. 25 (72.74 days) and No. 24 (74.78 days) at Aswan location in the second sowing date (Table5). Sivori (1975) reported a delay of 3 days in flowering of wheat by a delay of 15 days in sowing date. In addition, Nachit and Ketata (1987) stated that the number of days to heading tended to decrease by delaying sowing date. High temperatures after heading were detrimental to grain filling (Royo *et al.* 2006), especially for late-heading subpopulations. Spring varieties were the most stable regarding grain weight, probably because their earliness limited the damage to their grain formation caused by terminal stresses.

Table 5: Genotype means (G) at two locations (L) and two sowing dates (D) for flag leaf area and days to heading combined over two years.

Genotype No.	Flag leaf area (cm)					Days to heading				
	L1		L2			L1		L2		
	D1	D2	D1	D2	Mean	D1	D2	D1	D2	Mean
1	24.78	20.95	24.37	20.63	22.68	93.47	78.40	91.17	76.51	84.89
2	15.23	13.14	14.98	12.94	14.07	96.57	80.63	94.17	78.66	87.51
3	19.98	16.78	19.65	16.52	18.23	95.68	80.30	93.33	78.37	86.92
4	20.64	17.81	20.30	17.54	19.07	96.12	80.10	93.72	78.14	87.02
5	21.15	18.32	20.80	18.04	19.58	98.07	81.38	95.60	79.35	88.60
6	30.77	28.50	30.29	28.06	29.41	97.88	81.48	95.43	79.47	88.57
7	23.79	19.15	23.38	18.85	21.29	98.72	81.81	96.22	79.76	89.13
8	23.71	20.66	23.32	20.34	22.01	98.90	81.71	96.37	79.64	89.16
9	20.40	16.51	20.05	16.25	18.30	96.12	80.10	93.72	78.14	87.02
10	26.62	23.65	26.19	23.29	24.94	93.90	78.92	91.60	77.03	85.36
11	26.38	24.12	25.96	23.75	25.05	93.03	77.88	90.73	75.99	84.41
12	26.64	22.60	26.20	22.25	24.42	96.12	80.10	93.72	78.14	87.02
13	22.04	17.04	21.65	16.77	19.38	95.66	79.58	93.26	77.61	86.53
14	23.09	19.57	22.71	19.27	21.16	97.22	81.05	94.80	79.06	88.03
15	30.94	26.13	30.42	25.73	28.31	96.12	80.10	93.72	78.14	87.02
16	22.26	18.61	21.89	18.32	20.27	93.90	78.92	91.60	77.03	85.36
17	26.75	24.96	26.33	24.57	25.65	94.13	78.82	91.81	76.92	85.42
18	29.23	25.99	28.76	25.59	27.39	96.57	80.63	94.17	78.66	87.51
19	25.34	22.38	24.93	22.04	23.67	96.77	80.53	94.35	78.54	87.55
20	21.31	18.97	20.97	18.68	19.98	93.90	78.92	91.60	77.03	85.36
21	22.00	19.41	21.64	19.11	20.54	95.01	79.87	92.68	77.96	86.38
22	23.65	21.45	23.27	21.12	22.37	93.23	78.49	90.95	76.63	84.83
23	23.79	21.64	23.41	21.31	22.54	91.69	77.02	89.44	75.18	83.33
24	23.64	22.44	23.27	22.09	22.86	90.08	76.27	87.91	74.48	82.19
25	28.68	24.55	28.20	24.17	26.40	87.60	74.46	85.50	72.74	80.08
26	18.37	12.49	18.01	12.29	15.29	94.33	79.44	92.03	77.56	85.84
27	27.63	23.29	27.17	22.93	25.26	95.01	79.87	92.68	77.96	86.38
28	28.97	26.39	28.51	25.99	27.47	93.23	78.49	90.95	76.63	84.83
29	29.02	26.85	28.56	26.44	27.72	98.72	81.81	96.22	79.76	89.13
30	19.30	16.02	18.98	15.77	17.52	95.66	79.58	93.26	77.61	86.53
31	22.94	19.70	22.56	19.40	21.15	95.24	79.77	92.89	77.85	86.44
32	25.79	23.02	25.37	22.67	24.21	93.47	78.40	91.17	76.51	84.89
33	27.69	25.84	27.26	25.45	26.56	103.34	85.51	100.71	83.36	93.23
34	27.88	25.05	27.43	24.67	26.26	95.66	79.58	93.26	77.61	86.53
35	28.38	24.51	27.91	24.13	26.23	94.35	78.73	92.00	76.80	85.47
36	26.87	22.59	26.43	22.24	24.53	93.03	77.88	90.73	75.99	84.41
Mean	24.60	21.42	24.20	21.09	22.83	95.24	79.63	92.87	77.69	86.36

	LSD'$_{0.05}$	LSD'$_{0.01}$	LSD'$_{0.05}$	LSD'$_{0.01}$	
					Sohag location = L1
G	2.42	3.19	0.55	0.72	Aswan location = L2
					Favorable sowing date
LG	1.72	2.61	1.90	2.89	=D1
DG	0.33	0.43	0.11	0.15	Late sowing date = D2

Spike length:

The shortest spike length was 7.63 cm for genotype No. 19 under late sowing date at Aswan location, while the tallest spike length was 16.49 cm for genotype No. 18 at Sohag location under favorable sowing date with an overall average 11.34 cm (Table 6). Sowing at the favorable date at Sohag location caused taller spikes, because heat units and metabolites stored in favorable sowing date caused taller plants, vigorous growth and taller spikes. Hamam and Khaled (2009) reported sowing at the favorable date under Assiut location caused taller spikes, because heat units and metabolites stored in favorable sowing date caused taller plants, vigorous growth and taller spikes. In this regard, El Ameen (2012) found decreasing in spike length under late sowing date.

The number of kernels/spike:

The average of number of kernels/spike ranged from 31.11 (No. 9) to 66.96 (No. 18), with an overall average of 47.02 kernels. The trait decreased approximately 18.13% by delaying in sowing date (Table 6). Abdel-Majeed (2005) and El Ameen (2012) found some genotypes had high mean of number of kernel/spike under favorable conditions.

1000-Kernel weight:

The highest weight of kernel was found for genotype No. 19 (65.99 g) at Sohag location under the favorable sowing date, but the lowest value was for genotype No. 13 (22.88 g) under Aswan location in late sowing date with an overall average 45.25 g (Table 7). This may be due to high temperatures affecting the grain maturity which resulted in shrunk kernels. These results, were the same trend with obtained by Menshawy (2007) who reported high reduction in kernel weight were found under late planting; it could be fully accounted by the reduction in grain filling period. Tawfelis (2006) and El Ameen (2012) documented that delaying in sowing reduced 1000-kernel weight and grain yield. Previous studies have reported similar reduction in 1000-kernel weight in response to high temperature stress (Wardlaw *et al.* 2002, Hays *et al.* 2007 and Mondal *et al.* 2013). Although 1000-kernel weight was reduced in late sowing date, it is important to note that most entries with high 1000-kernel weight under high temperature stress also maintained higher 1000-kernel weight in Sohag than Aswan locations. Due to its association with grain yield, 1000-kernel weight was suggested as a selection criterion under high temperature stress (Reynolds *et al.* 1994, Yang *et al.* 2002 and Sharma *et al.* 2008).

Grain yield:

Grain yield of the genotypes ranged from 3.64 to 8.25 ton/ht. for genotypes No. 30 and No. 22, respectively, with an overall average of 5.79 ton/ht. The genotype No. 2 grown at Sohag produced the highest grain yield (9.27 ton/ht.) during the favorable condition of wheat sown (Table 7). The grain yield was greatly affected by the main yield components like number of kernels/spike and 1000-kernel weight.

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The delay in heading date under late sowing was attributed to grains could be affected by high temperature special during this period. Reducing in flag leaf area, spike length, number of kernels/spike and 1000-kernel weight caused a great reduction in grain yield. El Ameen (2012) reported that delaying the sowing date resulted in a substantial reduction in grain yield by 63.34%, while the genotypes under favorable conditions perform well for grain yield. Blum (1988) documented that drought stress during the grain filling period reduced grain yield. Reduction in grain yield reached 23% from as little as 4 days exposure to very high temperature (Randall and Moss 1990). Schulthess *et al.* (2013) reported, the genotype × environment interaction has more importance for the grain yield.

Stability analysis:

The joint regression analysis of variance (Table 8) revealed highly significant differences among genotypes for all studied traits. The partitioning of the genotype x environment interaction, as indicated by Env.+ (G x Env.), Env.(Linear), were highly significant for all studied traits. G x E (linear) was highly significant for all studied traits. Because G x E (linear) was significant, it could be proceeded in the stability analysis (Eberhart and Russell 1966).

Table 8: Joint regression analyses of variance studied traits of bread wheat over six environments (two sowing date, two years and two locations).

Source of variation	D.f	Means of squares					
		Flag leaf area	Days to heading	Spike length	Number of kernels/spike	1000-kernel weight	Grain yield
Genotypes (G)	35	335.69**	121.32**	44.01**	1598.33**	1090.16**	57.91**
Env.+ (G x Env.)	252	392.22**	7804.87**	103.84**	3334.43**	7777.28**	86.39**
Env. (linear)	1	796.13**	7600.37**	242.99**	5725.72**	2224.03**	78.86**
G x Env. (linear)	35	182.77**	2580.68**	79.33**	1951.17**	6871.21**	20.83*
Pooled deviation	216	0.14**	40.53**	0.35**	5.11**	45.34**	0.92**
Pooled error	560	0.001	0.0002	0.005	0.0002	0.006	0.004

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

Highly significant G x E interactions for many wheat traits were previously reported (Mahak *et al.* 2002; Mondal and Khajuria 2002; Kheiralla *et al.* 2004, Mahmoud 2006; Hamam and Khaled 2009 and El Ameen 2012). Flag leaf area (cm): The stability parameters (b_i and s^2_d) and the mean performance ($\bar{x}$) of the genotypes are presented in Table 9 and illustrated graphically in Fig.1. The genotypes No. 3, 8, 10, 14, L18, 19, 30, 31 and 34 were stable for flag leaf area which b_i was little more or less than one and S^2d_i equal to zero, therefore these genotypes were stable. Concerning of days to heading**,** the results indicated that out of thirty six, thirty four genotypes were unstable and gave significant S^2d_i (Table 9 and Fig.1).

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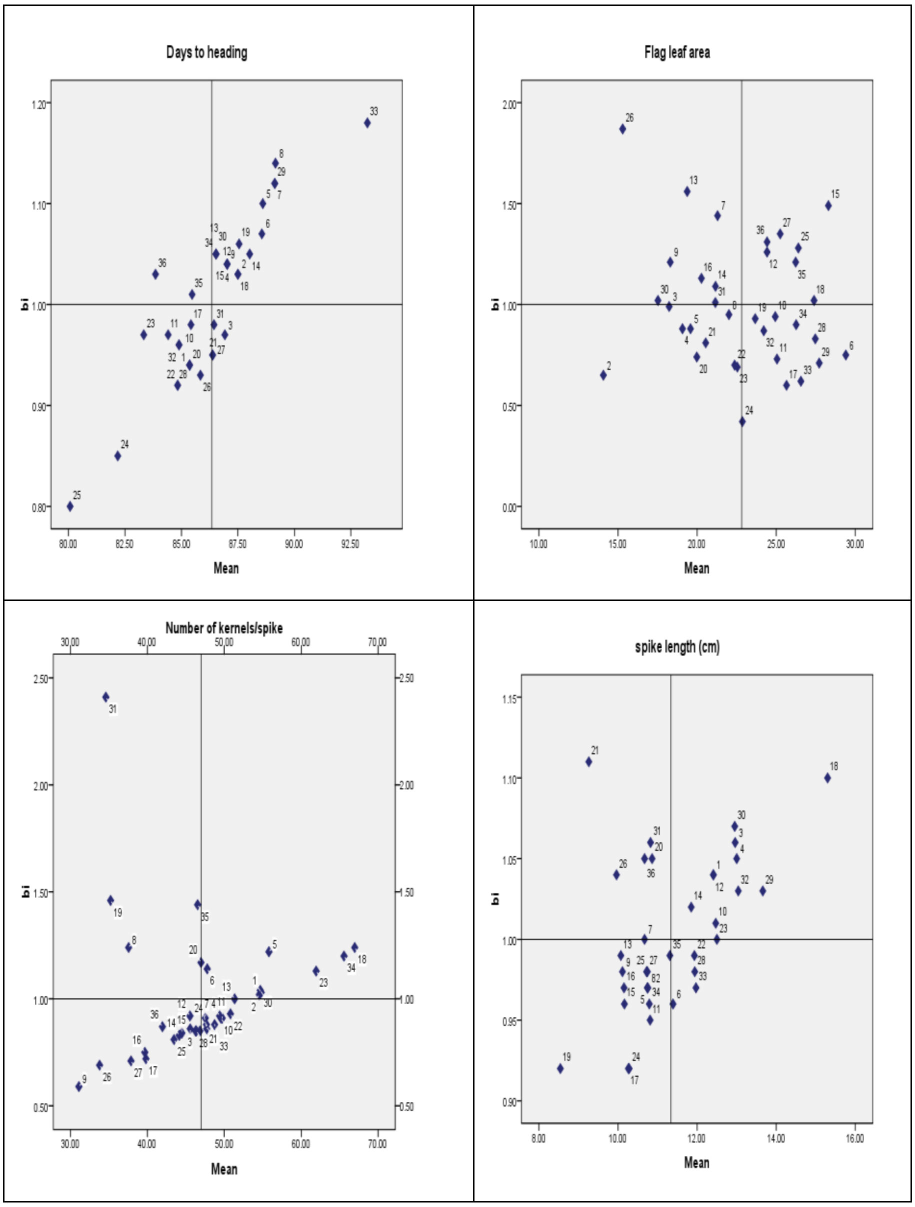

Fig. 1: Graphical illustration of the stability parameter (b_i) and mean performance genotypes ($\bar{x}$) for flag leaf area, days to heading, spike length and number of kernels/spike.

Genotypes No. 2 and 18 were stable and adapted to stress environments, whereas b_i and S^2d_i were not significant from unity and zero, respectively. The results of Spike length (cm) in Table 9 and Fig. 1 showed, genotypes No. 7, 10 and 23 were stable for spike length, whereas S^2d_i and b_i were not significant from unity and b_i was equal to one and S^2d_iequal to zero. As for number of kernels/spike, the genotypes No. 3, 4, 5, 12, 14, 15, 16, 20 and 25 were stable for number of kernels/spike (Table 10 and Fig. 1). In the meantime, the genotypes No. 4, 5, 12, 20 and 25 were also stable for 1000-kernel weight (Table 10 and Fig.2). 1000-kernel weight (g) genotypes No. 1, 2, 3, 4, 5, 8, 12, 14, 16, 20, 21 and 25 were stable for 1000-kernel weight, whereas the b_i for most genotypes was equal or more or less than one and S^2d_i tend to zero. There are also genotypes No. 5 and 14 which are stable for grain yield (Table 10 and Fig.2). Regarding to grain yield, results in Table 10 showed that genotypes No. 5, 6, 14, 20, 22, 24 and 32 were stable for grain yield. The b_i values for genotypes No. 6, 22 and 32 were less than one and this result indicated that, these genotypes were stable for stress environments. Finlay and Wilkinson (1963) further stated that the overall yield should be taken into account in addition to the regression of a genotype. Genotypes with a high mean yield and regression near 1.0 are then well adapted to all environments and as the mean yield decreases, a higher or lower regression indicates adaptation to favorable or unfavorable environments, respectively. Eberhart and Russell (1966) added that a stable variety would be one with a regression line slope near 1.0 with a small sum of squared deviations. Breese (1968) illustrated that the joint regression model was a powerful tool in the analysis of G x E interactions. Annicchiarico *et al.* (2006) also showed that joint regression model proved valuable for definition of recommendations on the basis of mean values of wheat. Thus, the linear regressions of individual genotypic values on the mean value of all genotypes for each environment provide measures of response which can be used to predict relative performance over a range of environmental conditions. Genotypes tend to have their own characteristic values for regression coefficient and deviation from regression mean square as shown in wheat by Joppa *et al.* (1971) and Busch *et al.* (1976). Genotypes with high yield and high stability can be found simultaneously using regression parameters as shown by Jalaluddin and Harrison (1993) in wheat.

The correlation between b_i and $\bar{x}$ for flag leaf area was negative (-0.17), respectively. Positive correlation was found for days to heading, spike length, number of kernels/spike, 1000-kernel weight and grain yield (0.89**, 0.50**, 0.07, 0.13 and 0.51**), respectively (Table 9 and 10). The positive and significant correlation for grain yield revealed that the studied genotypes exhibited high performance and high sensitivity to environments.

Table 10: Genotypes average performance over 6 environments and stability parameters of the thirty six wheat genotypes for number of kernels/spike, 1000-kernel weight and grain yield.

Genotype No.	Number of kernels/spike			1000 - kernel weight			Grain yield		
	$\bar{x}$	bi	S^2d_i	$\bar{x}$	bi	S^2d_i	$\bar{x}$	b_i	S^2d_i
1	54.80	1.03	0.01**	38.46	0.92*	0.00	4.12	0.61	0.24**
2	54.55	1.02	0.01**	43.46	0.97*	0.00	7.89	1.60*	0.07**
3	45.57	0.86*	0.01	44.22	0.99	0.00	7.25	1.21	0.15**
4	49.40	0.92*	0.01	42.84	0.97*	0.00	5.75	1.35*	0.01**
5	55.80	1.22*	0.00	45.28	0.99	0.00	5.30	1.09	0.00
6	47.78	1.14*	0.04**	56.07	1.10*	0.72**	6.71	0.71*	0.00
7	47.53	0.91*	0.04**	42.56	0.99	0.10**	4.82	0.69	0.02**
8	37.56	1.24*	0.09**	52.99	1.10*	0.00	4.02	0.36*	0.03**
9	31.10	0.59*	0.00	49.38	1.09*	0.08**	4.14	0.35*	0.14**
10	49.56	0.91*	0.03**	38.01	1.38*	4.41**	3.88	0.45*	0.03**
11	49.73	0.91*	0.09**	44.96	0.96	0.11**	5.56	1.30	0.07**
12	45.54	0.92*	0.00	41.28	0.95*	0.00	3.85	0.98	0.22**
13	51.34	1.00	0.23**	31.46	1.29*	14.75**	6.48	1.18	0.27**
14	44.14	0.83*	0.00	51.95	1.10*	0.00	7.89	1.14*	0.00
15	44.49	0.84*	0.00	42.06	1.22*	0.24**	3.85	0.56*	0.03**
16	39.67	0.75*	0.00	49.80	1.08*	0.00	3.68	0.78	0.02**
17	39.81	0.72*	0.08**	43.68	1.16*	0.53**	3.68	0.76	0.02**
18	66.95	1.24*	0.10**	39.04	0.16	5.48**	7.00	1.76*	0.09**
19	35.22	1.46	72.42**	56.99	1.15*	0.03**	7.90	0.79*	0.00
20	46.97	1.17*	0.00	33.87	0.93*	0.00	5.87	1.09	0.02
21	47.68	0.88*	0.02**	36.56	0.94*	0.00	7.41	1.36	1.17
22	50.80	0.93	0.07**	53.95	1.09*	0.18**	8.25	0.68*	0.00
23	61.94	1.13*	0.18**	48.44	1.01	0.12**	7.83	1.44	0.08**
24	47.72	0.86*	0.30**	35.33	0.82*	0.21**	5.95	1.39*	0.00
25	43.46	0.81*	0.00	43.99	0.99*	0.00	5.63	0.89	0.05**
26	33.79	0.69*	0.76**	40.30	1.04	10.56**	4.04	0.73	0.20**
27	37.87	0.71*	0.00	52.01	0.92*	0.06**	3.75	0.93	0.19**
28	46.37	0.85*	0.06**	43.49	0.95	0.07**	5.31	1.04	0.03**
29	46.83	0.85*	0.12**	36.15	0.86*	0.07**	7.66	1.44	0.23**
30	54.68	1.04	0.02**	48.03	0.87*	0.12**	3.64	1.13	0.13**
31	34.60	2.41*	977.19**	58.45	0.83*	0.36**	7.81	0.48	0.45**
32	46.26	0.85*	0.03**	49.01	0.93*	0.06**	6.53	0.99	0.00
33	48.74	0.88*	0.18**	52.61	1.05	0.74**	5.23	0.77	0.17**
34	65.56	1.20*	0.14**	47.52	1.01	0.04**	7.28	1.72	1.46**
35	46.53	1.44*	0.10**	45.38	1.14*	0.01	5.89	1.05	0.17**
36	41.96	0.87	2.28**	48.88	1.09	1.61**	6.50	1.11	2.82**
Mean	47.01			45.24			5.79		
r($\bar{x}$, b_i)	0.07			0.13			0.51**		

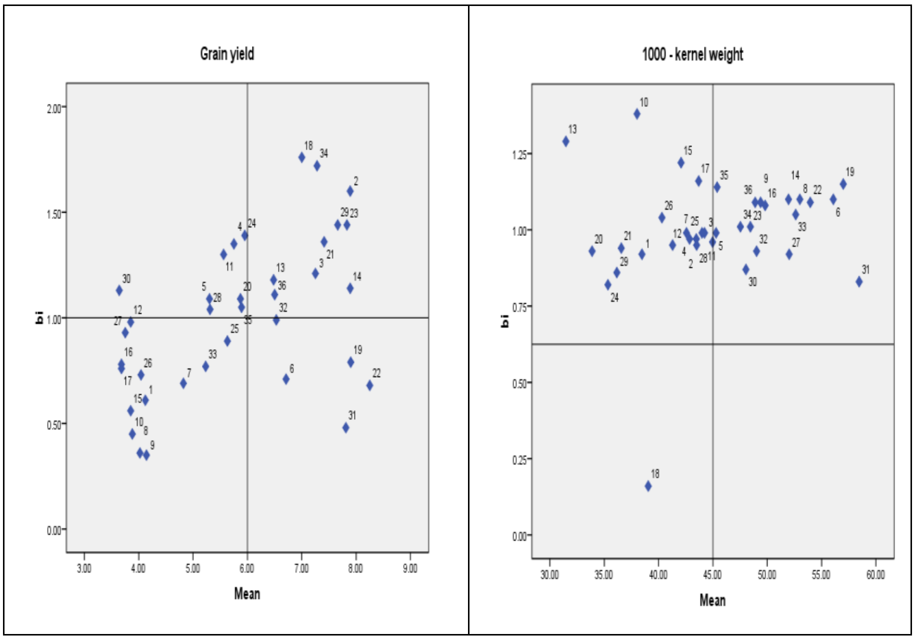

Fig. 2: Graphical illustration of the stability parameter (b_i) and mean performance genotypes ($\bar{x}$) for 1000-kernel weight and grain yield.

CONCLUSION

In conclusion, the characterizing bread wheat genotypes were mainly classified according to morpho-agronomic traits under heat stress conditions through different days of planting, different locations. The joint regression model is one of the useful methods to characterize the response of genotypes to environments. Breeding for high number of kernels/spike, 1000-kernel weight and grain yield, stability can be facilitated by calculating genotypes means and joint regression, in particular when the relationship between genotypic response and the environment is linear. Genotypes No. 2, 3, 18, 23, 29, 31 and 34 were unstable for high yielding, they are not adapted to Egyptian conditions. The genotypes No. 5, 6, 14, 19, 20, 22, 24 and 32 exhibited stability for grain yield and useful in the breeding program in developing new wheat genotypes with tolerance to heat stress conditions. This could be due to adaptation of these genotypes to wide differences in climatic conditions which prevailed at the two studied locations.

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الثبات والتنوع الوراثى لمكونات المحصول فى بعض التراكيب الوراثية للقمح خلال المواسم والإجهاد الحراري تحت مواقع مختلفة

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الثبات والتنوع الوراثى من العوامل الرئيسية لتحسين كثير من نباتات المحاصيل. حيث يتمثل التحدي الرئيسي لمربي النباتات هو انتخاب تركيب وراثى عالى المحصول يتصف بتأقلم واسع لظروف بيئية متنوعه. فى هذه الدراسه، تم تقييم ستة وثلاثين تركيب وراثي من قمح الخبز تحت موقعين (محافظتى سوهاج وأسوان بجمهورية مصر العربيه) فى موعدين زراعة، الاول الميعاد العادى المفضل و الثانى الزراعة المتأخرة، خلال موسمى الشتاء ٢٠١٣/٢٠١٢ و٢٠١٤/٢٠١٣ وذلك لتقدير آداء وثبات هذه التراكيب. نتيجة للاختلاف الكبير فى الظروف الجويه، ادى ذلك الى تباين واسع فى متوسط المحصول، تروواح من ٦.٥٩ طن / هكتار في حالة الزراعة فى الموعد المفضل إلى ٤.٩٩ طن / هكتار في حالة الزراعة المتأخرة (الإجهاد الحراري). كما أظهر تحليل التباين المشترك أن صفات مساحة ورقة العلم، تاريخ طرد السنابل، طول السنبلة، وزن الـ ١٠٠٠ حبة ومحصول الحبوب تأثرت معنويا بإختلاف السنوات، و الاماكن، و مواعيد الزراعة والتركيب الوراثية. ونلاحظ أن متوسط المحصول تراوح من ٢.٧٠ طن / هكتار إلى ٩.٢٧ طن / هكتار. وأظهرت النتائج أن الزراعة في الموعد المفضل آدت إلى تحسن فى جميع الصفات المدروسه. كما أظهر تحليل الانحدار المشترك انه يوجد تنوع بين هذه التراكيب الوراثيه. كما أظهرت النتائج أن التركيب الوراثية رقم ٥، ٦، ١٤، ١٩، ٢٠، ٢٢، ٢٤ و ٣٢ تتميز بثبات صفة محصول الحبوب ولذلك من المفيد استخدامها فى برامج التربية لتطوير تراكيب وراثيه جديدة تتحمل ظروف الحرارة المرتفعة.

ونلاحظ وجود ارتباط إيجابي بين انحدار ومتوسط صفات، تاريخ طرد السنابل، طول السنبلة، عدد الحبوب/سنبلة، وزن الـ ١٠٠٠ حبة ومحصول الحبوب (٠.٨٩ **، ** ٠.٥٠، ٠.٠٧، ٠.١٣ و ٠.٥١ **)، على التوالي. قد يكون هذا بسبب تأقلم هذه التراكيب الوراثية لاختلافات واسعة من الظروف البيئيه التي كانت سائدة في الموقعين محل الدراسه. ومن الممكن أن نلخص النتائج فى أن أفضل التراكيب الوراثية سواء تحت الظروف المفضلة أو ظروف الاجهاد الحرارى تشير إلى أن الانتخاب لتحسين المحصول قد يزيد المحصول فى مدى واسع من الظروف البيئية.

Table 1: Pedigree of the studied wheat genotypes

Genotype No.	Pedigree	Origin
1	BECARD/5/KAUZ//ALTAR 84/AOS/3/MILAN/KAUZ/4/HUITES	CIMMYT
2	ROLF07*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES	CIMMYT
3	TACUPETO F2001/BRAMBLING*2/5/KAUZ//ALTAR 84/AOS/3/MILAN/KAUZ/4/HUITES-1	CIMMYT
4	TACUPETO F2001/BRAMBLING*2/5/KAUZ//ALTAR 84/AOS/3/MILAN/KAUZ/4/HUITES-2	CIMMYT
5	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA-1	CIMMYT
6	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA-2	CIMMYT
7	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA-3	CIMMYT
8	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA-4	CIMMYT
9	BECARD/5/PGO//CROC_1/AE.SQUARROSA (224)/3/2*BORL95/4/CIRCUS	CIMMYT
10	WBLL1*2/KURUKU//HEILO	CIMMYT
11	KAUZ//ALTAR 84/AOS/3/MILAN/KAUZ/4/HUITES/5/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/6/KAUZ//ALTAR 84/AOS/3/MILAN/KAUZ/4/HUITES	CIMMYT
12	CAL/NH//H567.71/3/SERI/4/CAL/NH//H567.71/5/2*KAUZ/6/PASTOR*2/7 /CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*PASTOR	CIMMYT
13	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU-1	CIMMYT
14	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU-2	CIMMYT
15	PFAU/WEAVER*2//BRAMBLING/3/QUAIU	CIMMYT
16	MILAN/S87230//BAV92/5/PGO//CROC_1/AE.SQUARROSA (224)/3/2*BORL95/4/CIRCUS	CIMMYT
17	WBLL1*2/KKTS//KBIRD	CIMMYT
18	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/PVN	CIMMYT
19	KBIRD//INQALAB 91*2/TUKURU-1	CIMMYT
20	KBIRD//INQALAB 91*2/TUKURU-2	CIMMYT
21	PBW343*2/KUKUNA/3/PGO/SERI//BAV92	CIMMYT
22	CHEN/AE.SQ//WEAVER/3/SSERI1/4/TOBA97/PASTOR/5/MUU #1	CIMMYT
23	MUU #1/7/CAL/NH//H567.71/3/SERI/4/CAL/NH//H567.71/5/2*KAUZ/6/PASTOR/8/MUU	CIMMYT
24	UP2338*2/VIVITSI/3/FRET2/TUKURU//FRET2/4/OASIS/SKAUZ//4*BCN/3/2*PASTOR	CIMMYT
25	PBW343*2/KUKUNA*2//FRTL/PIFED-1	CIMMYT
26	PBW343*2/KUKUNA*2//FRTL/PIFED-2	CIMMYT
27	PBW343*2/KUKUNA*2//FRTL/PIFED-3	CIMMYT
28	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7-1	CIMMYT
29	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7-2	CIMMYT
30	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7-3	CIMMYT
31	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7-4	CIMMYT
32	UP2338*2/KKTS*2//YANAC	CIMMYT
33	WBLL1*2/4/BABAX/LR42//BABAX/3/BABAX/LR42//BABAX-1	CIMMYT
34	WBLL1*2/4/BABAX/LR42//BABAX/3/BABAX/LR42//BABAX-2	CIMMYT
35	Sides 12	Egypt
36	Egypt 1	Egypt

Table 6: Genotypes means (G) at two locations (L) and two sowing date (D) for plant spike length and number of kernels over two years.

Genotype No.	Spike length (cm)					Number of kernels/spike				
	L1		L2		Mean	L1		L2		Mean
	D1	D2	D1	D2		D1	D2	D1	D2	
1	13.48	11.76	13.02	11.36	12.41	60.29	50.43	59.03	49.43	54.80
2	11.75	10.11	11.34	9.77	10.74	60.02	50.21	58.77	49.21	54.55
3	14.06	12.31	13.58	11.89	12.96	50.14	41.94	49.09	41.10	45.57
4	14.10	12.35	13.61	11.93	13.00	54.35	45.46	53.21	44.56	49.40
5	11.75	10.12	11.35	9.77	10.75	62.24	50.53	60.92	49.53	55.81
6	12.42	10.76	11.99	10.39	11.39	53.83	42.72	52.69	41.88	47.78
7	11.67	10.04	11.27	9.69	10.67	52.30	43.76	51.19	42.88	47.53
8	11.76	10.13	11.36	9.78	10.76	43.81	32.13	42.83	31.49	37.57
9	11.10	9.49	10.71	9.16	10.12	34.23	28.63	33.51	28.05	31.11
10	13.55	11.83	13.08	11.43	12.47	54.53	45.62	53.39	44.72	49.57
11	11.81	10.18	11.41	9.84	10.81	54.71	45.78	53.57	44.88	49.74
12	13.49	11.77	13.03	11.37	12.42	50.40	41.63	49.34	40.80	45.54
13	11.05	9.44	10.67	9.12	10.07	56.51	47.25	55.31	46.29	51.34
14	12.90	11.21	12.46	10.83	11.85	48.57	40.63	47.55	39.82	44.14
15	11.14	9.53	10.76	9.21	10.16	48.96	40.95	47.93	40.13	44.49
16	11.13	9.52	10.75	9.20	10.15	43.65	36.51	42.73	35.78	39.67
17	11.24	9.64	10.86	9.32	10.27	43.79	36.64	42.88	35.92	39.81
18	16.49	14.63	15.93	14.13	15.30	73.66	61.63	72.12	60.41	66.96
19	9.47	7.91	9.14	7.63	8.54	41.96	29.24	40.94	28.73	35.22
20	11.94	10.16	11.53	9.81	10.86	53.11	41.82	51.97	40.99	46.97
21	10.37	8.47	10.01	8.18	9.26	52.45	43.88	51.36	43.01	47.68
22	12.98	11.29	12.54	10.91	11.93	55.88	46.76	54.72	45.84	50.80
23	13.58	11.86	13.11	11.46	12.50	68.14	57.01	66.72	55.89	61.94
24	11.26	9.66	10.88	9.33	10.28	52.48	43.92	51.40	43.07	47.72
25	11.74	10.10	11.34	9.76	10.74	47.82	40.00	46.81	39.20	43.46
26	10.94	9.32	10.56	9.00	9.96	37.21	31.09	36.40	30.45	33.79
27	11.72	10.09	11.32	9.74	10.72	41.67	34.85	40.79	34.16	37.87
28	12.99	11.30	12.54	10.92	11.94	51.01	42.68	49.95	41.84	46.37
29	14.78	13.01	14.28	12.57	13.66	51.51	43.10	50.45	42.26	46.83
30	14.05	12.29	13.56	11.88	12.95	60.17	50.33	58.90	49.32	54.68
31	11.90	10.11	11.49	9.77	10.82	44.93	25.11	43.67	24.67	34.60
32	14.14	12.39	13.66	11.97	13.04	50.89	42.58	49.83	41.74	46.26

33	13.02	11.33	12.57	10.95	11.97	53.61	44.86	52.50	43.98	48.74
34	11.79	10.16	11.39	9.82	10.79	72.12	60.34	70.62	59.15	65.56
35	12.34	10.67	11.91	10.31	11.31	53.82	40.23	52.63	39.43	46.53
36	11.72	10.08	11.32	9.74	10.72	46.48	38.90	45.50	38.12	42.25
Mean	12.38	10.70	11.95	10.33	11.34	52.26	42.75	51.15	41.91	47.02

		$LSD'_{0.05}$	**$LSD'_{0.01}$**		**$LSD'_{0.05}$**	**$LSD'_{0.01}$**	**Sohag location = L1**
G		**2.46**	**1.15**		**3.59**	**4.73**	**Aswan location = L2**
LG		**3.26**	**4.33**		**2.97**	**4.52**	**Favorable sowing date = D1**
DG		**0.07**	**0.03**		**0.55**	**0.73**	**Late sowing date = D2**

Table 9: Genotypes average performance over 6 environments and stability parameters of the thirty six wheat genotypes for flag leaf area, days to heading and spike length.

Genotype No.	Flag leaf area (cm)			Days to heading			Spike length (cm)		
	$\bar{X}$	bi	S^2d_i	$\bar{X}$	bi	S^2d_i	$\bar{X}$	b_i	S^2d_i
1	22.69	1.19*	0.000	84.89	0.96	0.71**	12.41	1.04	0.000
2	14.07	0.65*	0.000	87.50	1.03	0.00	10.74	0.97	0.000
3	18.23	0.99	0.000	86.92	0.97	1.77**	12.96	1.06	0.000
4	19.07	0.88*	0.000	87.02	1.04	0.46**	13.00	1.05	0.000
5	19.58	0.88*	0.000	88.60	1.10	21.07**	10.75	0.97	0.000
6	29.40	0.75*	0.006**	88.56	1.07	1.72**	11.39	0.96	0.000
7	21.29	1.44*	0.005**	89.13	1.12	44.76**	10.67	1.00	0.000
8	22.01	0.95*	0.000	89.16	1.14	167.18**	10.75	0.97	0.000
9	18.30	1.21*	0.003	87.02	1.04	0.46**	10.11	0.98	0.000
10	24.94	0.94*	0.000	85.36	0.94	4.62**	12.47	1.00	0.000
11	25.05	0.73*	0.002	84.41	0.97	0.02**	10.81	0.95	0.000
12	24.42	1.26*	0.000	87.02	1.04	0.46**	12.41	1.04	0.000
13	19.37	1.56*	0.023**	86.53	1.05	3.61**	10.07	0.99	0.001**
14	21.16	1.09*	0.000	88.02	1.05	0.25**	11.85	1.02	0.000
15	28.30	1.49*	0.000	87.02	1.04	0.46**	10.16	0.96	0.000
16	20.27	1.13*	0.000	85.36	0.94	4.62**	10.15	0.97	0.000
17	25.65	0.60*	0.006**	85.42	0.98	0.06**	10.26	0.92*	0.000
18	27.39	1.02	0.000	87.50	1.03	0.00	15.30	1.10	0.006**
19	23.67	0.93*	0.000	87.55	1.06	2.53**	8.54	0.92	0.001**
20	19.98	0.74*	0.000	85.36	0.94	4.62**	10.86	1.05*	0.000
21	20.54	0.81*	0.000	86.38	0.95	6.25**	9.26	1.11	0.000
22	22.37	0.70*	0.000	84.83	0.92	12.89**	11.93	0.99	0.000
23	22.54	0.69*	0.001	83.33	0.97	2.31**	12.50	1.00	0.000
24	22.86	0.42*	0.008**	82.18	0.85	86.68**	10.28	0.92	0.000
25	26.40	1.28*	0.000	80.07	0.80	203.06**	10.74	0.98	0.000
26	15.29	1.87*	0.397**	85.84	0.93	16.32**	9.96	1.04	0.008**
27	25.25	1.35*	0.000	86.38	0.95	6.25**	10.72	0.98	0.000
28	27.47	0.83*	0.002	84.83	0.92	12.89**	11.94	0.98	0.000
29	27.72	0.71*	0.005**	89.13	1.12	44.76**	13.66	1.03	0.003**
30	17.52	1.02	0.000	86.53	1.05	3.61**	12.95	1.07	0.000
31	21.15	1.01	0.000	86.44	0.98	0.14**	10.82	1.06*	0.000
32	24.21	0.87*	0.000	84.89	0.96	0.71**	13.04	1.03	0.000
33	26.56	0.62*	0.006**	93.23	1.18	95.06**	11.97	0.97	0.000
34	26.26	0.90*	0.000	86.53	1.05	3.61**	10.79	0.96*	0.000
35	26.23	1.21*	0.000	85.47	1.01	0.06**	11.31	0.99*	0.000
36	24.42	1.31*	0.012**	83.85	1.03	3.13**	10.67	1.05	0.000
Mean	22.82			86.34			11.34		
r($\bar{X}$, bi)	-0.17			0.89**			0.50**		

Table 7: Genotypes means (G) at two locations (L) and two sowing date (D) for and 1000-Kernel weight and grain yield over two years.

Genotype No.	1000-Kernel weight (g.)					Grain yield (ton/ht.)				
	L1		L2		Mean	L1		L2		Mean
	D1	D2	D1	D2		D1	D2	D1	D2	
1	45.37	32.76	43.96	31.76	38.46	4.61	3.76	4.48	3.65	4.13
2	50.93	37.35	49.36	36.21	43.46	9.27	6.72	9.04	6.53	7.89
3	51.78	38.05	50.18	36.89	44.23	8.36	6.32	8.16	6.16	7.25
4	50.24	36.77	48.69	35.65	42.84	6.97	4.69	6.79	4.57	5.76
5	52.95	39.01	51.32	37.82	45.28	6.28	4.46	6.11	4.34	5.30
6	64.96	48.91	62.98	47.45	56.08	7.41	6.20	7.21	6.04	6.72
7	49.93	36.52	48.38	35.40	42.56	5.51	4.25	5.37	4.15	4.82
8	61.53	46.08	59.64	44.69	52.99	4.31	3.84	4.19	3.73	4.02
9	57.53	42.78	55.75	41.48	49.39	4.40	3.99	4.28	3.87	4.14
10	48.07	29.18	46.52	28.29	38.02	4.22	3.63	4.11	3.53	3.87
11	52.60	38.72	50.99	37.55	44.97	6.75	4.51	6.58	4.41	5.56
12	48.50	35.34	47.00	34.26	41.28	4.67	3.14	4.53	3.05	3.85
13	40.33	23.63	39.00	22.88	31.46	7.39	5.75	7.19	5.57	6.48
14	60.38	45.13	58.52	43.76	51.95	8.90	7.09	8.67	6.90	7.89
15	51.03	34.43	49.41	33.38	42.06	4.32	3.49	4.20	3.40	3.85
16	57.99	43.16	56.20	41.84	49.80	4.34	3.12	4.22	3.04	3.68
17	52.67	36.05	51.03	34.96	43.68	4.32	3.14	4.21	3.06	3.68
18	40.43	38.83	39.24	37.66	39.04	8.62	5.56	8.40	5.42	7.00

19	65.99	49.76	63.97	48.26	57.00	8.62	7.40	8.38	7.20	7.90
20	40.94	27.86	39.66	27.01	33.87	6.87	5.02	6.70	4.89	5.87
21	43.71	30.56	42.35	29.62	36.56	8.70	6.29	8.49	6.14	7.41
22	62.60	46.97	60.69	45.56	53.96	8.89	7.83	8.66	7.62	8.25
23	56.46	41.90	54.74	40.64	48.44	9.00	6.88	8.77	6.67	7.83
24	41.87	29.88	40.59	28.97	35.33	7.19	4.86	7.00	4.73	5.95
25	51.52	37.83	49.93	36.68	43.99	6.48	4.93	6.29	4.81	5.63
26	47.42	34.46	45.92	33.38	40.30	4.64	3.55	4.51	3.45	4.04
27	59.12	46.50	57.32	45.10	52.01	4.49	3.12	4.37	3.03	3.75
28	50.96	37.37	49.40	36.24	43.49	6.29	4.47	6.12	4.36	5.31
29	42.88	30.53	41.57	29.61	36.15	9.00	6.52	8.78	6.35	7.66
30	54.69	42.84	53.02	41.54	48.02	4.60	2.78	4.47	2.70	3.64
31	65.11	53.58	63.14	51.97	58.45	8.34	7.47	8.14	7.28	7.81
32	56.38	43.14	54.67	41.84	49.01	7.41	5.84	7.21	5.67	6.53
33	61.10	45.73	59.24	44.36	52.61	5.87	4.74	5.70	4.60	5.23
34	55.44	41.06	53.74	39.82	47.52	8.83	5.92	8.63	5.77	7.29
35	54.02	38.16	52.34	37.00	45.38	7.13	5.39	6.26	4.76	5.89
36	57.47	42.73	55.70	41.44	49.34	8.04	5.87	7.17	5.24	6.58
Mean	52.91	38.99	51.28	37.80	45.25	6.70	5.07	6.48	4.91	5.79

	$LSD'_{0.05}$	$LSD'_{0.01}$	$LSD'_{0.05}$	$LSD'_{0.01}$	
G	**2.98**	**3.93**	**0.87**	**1.14**	**Aswan location = L2**
LG	**2.78**	**4.83**	**10.00**	**17.35**	**Favorable sowing date = D1**
DG	**0.58**	**0.76**	**0.18**	**0.24**	**Late sowing date = D2**

Sohag location = L1