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ESTIMATING STABILITY PARAMETERS IN SOME WHEAT GENOTYPES UNDER DIFFERENT ENVIRONMENTS

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ABSTRACT

Two field experiments were carried out at the Faculty of Agriculture, Minufiya University during 2003/2004 and 2004/2005 seasons. The aim of this study was to determine stability parameters of sixteen wheat genotypes under different levels of irrigation treatments (three or five irrigations) and nitrogen fertilizer (35 or 70 kg.N./fed.) for yield and some of its components. The phenotypic stability according to Eberhart and Russell (1966) cleared that the genotypes Line 19 and Line 33 had low (bi) values for all traits studied and thus, are more adapted for stress conditions. The genotypic stability according to Tai (1971) showed that Giza 164, Line 10 and Line 30 had average stability, Sakha 93, Gemmieza 7, Zazora 1, V. 21 and Line 11 with below average stability, while Line 18 with above average stability, the last lines are more responsive to the improving environments.The genotypes Sakha 69, Sakha 8, V. 22, Line 12, Line 13, Line 19 and Line 33 were unstable under the experimental conditions. The yield stability statistics according to Kang (1993) showed that the selected genotypes under this study are Line 18, Line 13, Line 11 and Giza 164 which characterized with high (YSi).

Key words: ***Wheat, Irrigation, Fertilization, Stability.***

INTRODUCTION

Wheat *(Triticum aestivum* L.) is the most widely grown cereal crop in the world. Wheat is the main diet for the Egyptian population also, it has been considered the first strategic food crop. Wheat is the main winter cereal crop and is widely distributed all over the country (cultivated area = 3.00 million faddan in 2005/2006 seasons) and the mean production of wheat in Egypt in the valley and Delta regions is about 18.18 ardab/fed. The country imported about 55% of the total consumption of wheat about 5.4 million ton in the 2006 season. Therefore, increasing production becomes an important national goal to reduce the gab between wheat production and food consumption, as well as, reduce wheat imports and save foreign currency. It was anticipated that high and stable wheat yield could be achieved by applying the most favorable cultural practices and using high yielding varieties.

Variation of the environment can be divided into two sorts, predictable and unpredictable. The first category includes all permanent characters of the environments, such as general *etfeatures* of the climate and soil type, as well as these characteristics of the environment which fluctuate in a systematic manner, such as day length. It also includes those aspects of environment that are controlled by man and can therefore be fixed more or less as well, such as planting date, sowing density, methods of harvest and other agronomic practices. The second category includes fluctuation in weather, such as amount and distribution of rainfall and temperature.

This investigation was carried out to compare and determine the relative importance of three methods of estimating stability proposed as follows:-

1- The regression coefficient (b_i) of genotype mean on environmental index and the deviation mean square from regression ($S2_d$) according to Eberhart and Russell (1966).
2- Tai Method (1971) was used only for grain yield (ard./fed.)
3- The stability variance (δ2i) as outlined by Shukla (1972) and the yield stability (YSi) statistic which developed by Kang (1993).

1- Eberhart and Russell (1966):

This model provides means of partitioning the genotype-environmental interaction of each variety into two parts:

a- The variation due to the response of the variety to varying environmental indices (sums of squares due to regression).
b- The unexplainable deviations from the regression on the environmental index. The ideal genotype must be characterized by three characteristics.
c- Regression coefficient should be significantly different from zero ($b \neq 0$) and not significantly differed from unity ($b=1$).
d- Minimum value of the deviation from linear regression i.e., ($S2d=0$).
e- High yield performance with a reasonable of environmental variations.

The present investigation aimed to share in solving the problem of the low production of wheat grain yield by studying the yield productivity of the commercial and newly released varieties and determining the proper irrigation and nitrogen fertilizer levels to obtain maximum yield. In addition this investigation may help wheat breeders to get information on the important plant characters influencing wheat yield.

Plant breeder usually tests his best experimental genotypes in replicated yield trials at several locations and usually for more than one year. The stability of yield is very important in crops specially when grown in different environments. The best genotype is the one that show a consistently high performance over several environments.

The present study aims to evaluate the stability parameters of sixteen different wheat genotypes for grain yield and some attributes under eight environments (2 irrigation levels x 2 nitrogen fertilizer levels x 2 years) and assess the phenotypic and genotypic, yield stability of these genotypes.

MATERIALS AND METHODS

Sixteen bread wheat genotypes were evaluated under eight diverse environments. The genotypes included six common commercial varieties i.e., Sakha 8, Sakha 69, Sakha 93, Giza 164, Gemmieza 7 and Zarzora 1 and ten new lines from Wheat Research Department, Field Crop Research Institute, Agricultural Research Center (ARC), Giza, Egypt. The eight environments were the combinations between two levels of irrigation (three and five irrigations) and two levels of nitrogen fertilization (35 and 70 kg.N./fed.) during two successive seasons 2003/2004 and 2004/2005. A split-split plot design with three replications in a randomized complete block arrangement was used in bath seasons. Irrigation regime levels were randomly allocated to the main plot, nitrogen fertilizer levels were assigned in the sub- plots, while wheat genotypes occupied the sub- sub plots.

At harvest, twenty plants were taken at random from the inner rows in each sub-sub plot to estimate number of spikes/m2, number of grains / spike, 1000- grain weight and grain yield in ardab per faddan.

The obtained data were subjected to the 0.05 probability level of significance according to Cochran (1967). The analysis of variance over years, irrigations and fertilizations was calculated as outlined by Allard (1960) to asses the phenotypic stability. Three stability techniques were used for comparing wheat genotypes as follows:

1- Eberhart and Russell (1966) to determine phenotypic stability.
2- Tai (1971) for estimating genotypic stability.
3- The yield stability (Ysi) as developed by Kang (1993).

The mechanism of yield stability (Kang, 1993) has been finalized through yield components. Yield-stability (Ysi) statistic was calculated using the program STABLE (a basic program for calculating stability and yield-stability statistic) after Kang and Magari (1995). Data of irrigation and nitrogen fertilization levels were used for calculate the genotypes stability indices across all environments. Steps to calculate the (Ysi) statistic for the ith genotypes are listed below:

(1) Determine the contribution of each genotype to GE interaction by calculating i2 (Shukla 1972) as follows:

$$\sigma_i^2 = \left[\frac{1}{(s-1)(t-1)(t-2)}\right] x \left[t(t-1)\sum_j (\bar{\mu}_{ij} - \bar{\mu}_{i.})\right]$$

Where: $\mu_{ij} = X_{ij} - X_j - X_{ij}$ observed trait (yield) value of ith genotype in jth environment. X_{ij}= mean of all genotypes in a j_{th} environment. $\bar{\mu}_i = \sum_j \mu_{ij} / s$, s= number of environments, and t= number of genotypes. The σ_i^2 can be efficiently computed using Kang's (1989) SAS program interactive BASICA program (Kang, 1988, 1993) and Kang and Magari (1995).

(2) Arrange genotypes from the highest to the lowest yield and assign yield rank (Y), with the lowest yielding genotype receiving the rank of 1.

(3) Calculate protected LSD α (2) for mean yield comparisons {α (2) refers to a two-tailed test} as tα (2), v (2 EMS/S x r1/2), where EMS = error mean squares, v= *df* associated with EMS, and r = number of replications;

(4) Adjust Y, according to LSD, and determine adjusted yield rank (Y1);

(5) Assign respective stability-variance stability (σ_i^2) values to genotypes and determine whether or not σ_i^2 is significant α (2) = 0.1, 0.05, 0.01, using an approximate F-test with (S-1), v *df* (a significant σ_i^2 2 indicates that genotype performance across environments was unstable);

(6) Assign stability rating (S) as follows: -8,-4, and-2 for σ_i^2 ignificant at α = 0.01, 0.05, and 0.l, respectively; and 0 for no significant σ_i^2 {the stability ratings of -8, -4 and -2 were chosen because they changed genotype ranks from those based on yield alone (Y).

(7) Sum adjusted yield rank (Y) and stability rating (S) for each genotypes to determine Ys_i, statistic.

(8) Calculate mean Ys_i as $\Sigma Ys_i/t$. Select genotypes with $Ys_i >$ the mean Ys_i. Yield-stability (Ys_i) statistic was calculated by computer program STABLE (a basic program for calculating stability and yield-stability statistic) after Kang and Magari (1995).

RESULTS AND DISCUSSION

The analysis of variance of all traits studied and the combined analysis of variance for grain yield and its components i.e. number of spikes/m2, number of grains/spike and 1000-grain weight which presented in Table (1). Environment mean squares were found to be significant for all traits studied indicating that the performance of these traits was differed from environment to another. Genotypes mean squares were significant for grain yield and its components. Also, significant mean squares of the genotypes and environment interactions were detected, indicating that genotypes carried genes with different additive and additive by additive gene effects which seemed to be inconstant from environment to another. These results were interpreted as that averaged overall environments. Significant differences among genotypes were exhibited for grain yield and its components and the genotypes responded differently at the different environments. This may lead to the conclusion that it is essential to determine the degree of stability of each genotype.

Table 1. Analysis of variance for yield and its components of the studied wheat genotypes stability.

Source of variance	Df	Mean squares			
		No. of spikes/m2	No. of grains/spike	1000-grain weight (g)	Grain yield (ard./fed.)
Varieties	15	5941.967	153.23**	6.55**	8.89**
ENV + VAR × ENA	112	2811.857	778.52**	168.302**	124.333**
ENV Linear	1	235919.2	601.09**	690.9155**	601.64**
VAR × ENV (Linear)	15	1844.985	35.82**	6.193**	3.956**
Pooled deviation	96	534.916	5.49**	2.354	0.886**
G1 Sakha 93	6	1361.97	7.1**	1.513	0.913**
G2 Sakha 69	6	1084.18	9.77**	0.533	3.802**
G3 Sakha 8	6	68.03	3.3**	1.233	0.996**
G4 Giza 164	6	466.08	6.7**	0.7	0.248**
G5 Gemmieza 7	6	417.18	5.39**	3.192	0.641*
G6 Zarzora 1	6	886.72	6.37**	0.232	1.369**
G7 V. 21	6	317.949	1.41	1.063	1.102**
G8 V. 22	6	788.64	11.01**	1.363	1.012**
G9 line 10	6	205.46	2.06	0.553	0.229
G10 line 11	6	287.37	1.51	0.535	0.265*
G11 line 12	6	952.97	7.53**	0.28	0.632**
G12 line 13	6	221.42	9.08**	3.392*	0.711**
G13 line 18	6	557.709	2.92*	21.81**	0.127
G14 line 19	6	600.472	5.33**	0.222	0.605**
G15 line 30	6	399.78	6.22**	0.365	0.148
G16 line 33	6	109.403	2.17	0.643	1.369**
Pooled error	256	80.396	1.04	1.506	0.115

The analysis of variance showed also that the pooled deviation reached the level of significance indicating that the genotypes differed significantly with respect to their deviation from their respective average linear response. Also, it is interesting to note that the pooled deviation mean squares for the studied genotypes were found to be significant for most traits studied except 1000-grain weight, whereas, the opposite direction was detected. Generally, the genotypes (Sakha 93, Sakha 69, Sakha 8, Giza 164, Gemmieza 7, Zarzora 1, V. 22, line 12, line 18 and line 19 had significantly pooled deviation for most traits studied. These results are in agreement with those obtained by Bassiuony (1985), Ghandorah (1989) and Salem *et al* (2002).

Stability according to Eberhart and Russell (1966)

As mentioned before, a stable population is defined as one with regression coefficient (bi) near 1.0 and deviation from regression (S2d) approaching 0.0. A high mean yield also is a desired attribute, although it is not necessarily as an indicator for stability performance. However, Breese (1969), Paroda and Hayes (1971) and Paroda *et al* (1973) considered the square deviation from regression (S2d) as a measure of the response of a particular genotype to environmental indices. The significant linear

Table (2): Phenotypic stability parameters for 1000-grain weight (g) and Grain yield (ard./fed.) of the studied wheat genotypes.

Stability parameters / Genotypes	1000 grain weight (g)			Grain yield (ard/fed.)		
	$\bar{X}$	bi	S2d	$\bar{X}$	bi	S2d
G1. Sahka 93	48.976	0.803**	0.01	16.45	1.332**	72.23**
G2. Sahka 69	50.1	0.693**	0.97**	15.234	0.971**	58.24**
G3. Sahka 8	49.708	1.409**	0.27	13.924	0.817**	31.06**
G4. Giza 164	48.358	0.874**	0.77**	15.196	1.362**	71.19**
G5. Gemmieza 7	49.101	1.659**	1.69**	17.024	1.236**	61.32**
G6. Zarzora 1	50.303	0.703**	1.27**	15.115	1.117**	60.32**
G7. V. 21	49.776	1.791**	0.44	13.61	1.737**	120.08**
G8. V. 22	50.749	1.305**	0.14	15.409	0.636**	21.29**
G9. Line 10	49.326	1.095**	0.95**	12.985	0.853**	28.75**
G10. Line 11	49.684	0.722**	0.97**	16.203	1.226**	59.99**
G11. Line 12	50.078	0.594**	1.23**	13.495	0.838**	30.19**
G12. Line 13	48.154	1.151**	1.89**	16.186	0.558**	15.97**
G13. Line 18	51.236	1.035**	20.30**	18.729	0.762**	22.59**
G14. Line 19	48.88	0.482**	1.28**	15.99	0.991**	40.57**
G15. Line 30	47.766	0.837**	1.14**	14.79	0.893**	30.90**
G16. Line 33	47.825	0.848**	0.86**	16.255	0.591**	21.33**
Mean of B	1.00			1.00		
Standard error	0.2335			0.1535		
Population mean	49.28			14.923		
	No. of spikes/m2			No. of grains/spike		
G1. Sahka 93	534.625	1.115**	26.51**	62.408	0.986**	6.06**
G2. Sahka 69	513.4	1.336**	32.8**	61.853	1.468**	8.73**
G3. Sahka 8	536.463	0.891**	12.11**	56.193	0.541**	2.26**
G4. Giza 164	558.875	1.238**	25.39**	60.76	1.165**	5.66**
G5. Gemmieza 7	508.25	1.483**	34.95**	69.3	1.373**	4.36**
G6. Zarzora 1	499.063	1.296**	30.1**	56.91	1.068**	5.33**
G7. V. 21	489.863	1.12**	20.4**	54.373	1.963**	0.37**
G8. V. 22	494.763	0.544**	90.87**	54.865	1.284**	9.97**
G9. Line 10	539.038	0.438**	40.62**	50.95	0.927**	1.02**
G10. Line 11	569.375	0.909**	13.92**	58.908	0.735**	0.46**
G11. Line 12	502.5	1.245**	28.56**	56.853	0.47**	6.49**
G12. Line 13	541.075	0.626**	71.06**	59.348	0.871**	8.03**
G13. Line 18	540.625	0.434**	61.19**	60.035	0.717**	1.88**
G14. Line 19	540.838	0.937**	15.54**	54.71	0.593**	4.29**
G15. Line 30	535.925	1.522**	36.55**	54.838	1.187**	5.18**
G16. Line 33	586.525	0.867**	1.74**	55.28	0.652**	1.13**
Mean of B	1.00			1.00		
Standard error	0.1905			0.1561		
Population mean						

interaction indicated that all genotypes behaved differently within the varied years.

Paroda and Hayes (1971) advocated that the linear regression could simply be regarded as a measure of response of a particular genotype which in fact is dependent on number of genotypes included in particular study. In this connection, Breese (1969) reported that genotypes with regression coefficient (bi) greater than one would be adapted to more favourable environments, while, the genotypes with regression coefficient (bi) lower than one would be adapted to stress environments. Regarding no. of spikes/m2, the regression coefficient ranged from 0.43 to 1.525 Table (3).

The genotypes Sakha 93, Sakha 69, Giza 164, Gemmieza 7, Zarzora 1, V. 21, Line 11, and Line 30 had (bi) values larger than one, suggesting that these genotypes would be responsive to optimum cultural practices (favorable conditions). Meanwhile, (bi) values lower than one were obtained by the genotypes Sakha 8, V. 22, Line 10, Line 12, Line 13, Line18, Line 19 and Line 33, suggesting that these genotypes might be adapted for abnormal conditions (stress conditions). These results are in agreement with those obtained by Ibrahim (2004) and Moussa *et al* (2006).

With respect to no. of grains/spike, (bi) ranged from 0.470 to 1.963 Table (2). High values of (bi) coefficient were obtained by the genotypes Sakha 69, Giza 164, Gemmieza 7, Zarzora 1, V. 21, V. 22, and Line 30. This suggested that these genotypes would be adapted for favorable conditions. In contrary, the genotypes Sakha 93, Sakha 8, Line 10, Line 12, Line 13, Line 18 and Line 33 had the lowest values of (bi), suggesting that these genotypes would be adapted to stress conditions. The same trend was obtained by Salem *et al* (2002).

Regarding to 1000-grain weight (bi) values ranged from 0.482 to 1.790 Table (2). The genotypes Sakha 8, Gemmieza 7, V. 21, V. 22, Line 10, Line 13 and Line 18 had (bi) values larger than one. Consequently, these genotypes are more adapted to favorable conditions. Meanwhile the remaining genotypes i.e. Sakha 93, Giza 164, Zarzora 1, Line 11, Line 12, Line 19, Line 30 and Line 33 by having (bi) values lower than one would be adapted to unfavorable conditions. Similar results were obtained by Badhe *et al* (1998).

With regard to grain yield/fed., the (bi) values ranged from 0.558 to 1.737. The largest (bi) values were obtained by the genotypes Sakha 93, Giza 164, Gemmieza 7, Zarzora 1, V. 21 and Line 11. Consequently, these genotypes would be adapted for favorable conditions (Table 2). While the rest of genotypes (Sakha 69, Sakha 8, V. 22, Line 10, Line 12, Line 13, Line 19, Line 30 and Line 33) had the lowest values of (bi) suggesting that these genotypes would be adapted for stress conditions. These results are in agreement with those obtained by El-Dafrawy *et al* (1994), Awaad and Aly (2002) and Moussa *et al* (2006).

As shown in Table (2), the regression coefficient (bi) values of most genotypes on the environmental means were significantly different from zero. However, the genotypes gave the highest (bi) values expressing its high instability. This could be due its susceptibility to wheat rusts (Moussa, 2006). On the other hand ten genotypes in grain yield were responsive to the environmental conditions and showing regression slope (b_i) not differed from unity (b = 1) indicating wide adaptability over all environments under study. These results are in general agreement with Eberhart and Russell (1966) who find an ideal genotypes as the genotype of the highest yield over a wide range of environments with a regression coefficient value of unity and deviation from regression close to zero as possible ($S2_d = 0.0$). In the case of significance of (b_i) values and the deviation from regression ($S2_d$) is considered the most appropriate criterion for measuring the phonotypic stability, Baker *et al,* (1982).

Some of the unstable genotypes (Sakha 93, Giza 164, Gemmieza 7, Zarzora 1, V. 21 and Line 12) seemed to have high grain yield above the grand mean. These genotypes, however, could not be overlooked because their high yield potentiality was limited to a particular year. Meanwhile, other genotypes were unstable with regression coefficient less than 1 ($b > 1$) usually had high yield below the grand mean. These genotypes might be fruitful under poor environments i.e., low fertilizations and irrigations. These results are in general agreement with those obtained by Moussa *et al*. (2006).

Finally, from the previous results of (bi) values in Table (3), it could be assertain that Line 19 and Line 33 which had low b_i values for the traits studied are more adapted for stress conditions. Meanwhile, the genotypes Gemmieza 7 and V. 21 which exhibited larger b_i values for all traits are more adapted for favorable conditions.

Table 3. Stability analysis of variance for grain yield across genotypes and environments (According to Tai, 1971).

S.O.V	D.F	M.S
Environments	7	258.75**
Reps in environment	16	0.446 N.S
Varieties	15	26.3**
Environments X Varieties	105	4.10**
Linear response	15	0.506NS
Dev. form linear Response	90	
Error	240	0.372
Total	383	

Tai Method (1971) to estimate genotypic stability for grain yield:

The analysis of variance for grain yield/fed. across genotypes and environments indicated that the environment, genotypes and genotypes X environment (GE) interaction were found to be highly significant for grain yield/fed. (Table 4).

The environments mean square was found to be significant, indicating that the two treatments of both irrigations and fertilizations in the two years provided a sufficient range of environments, and hence the validating the environmental requirements suggested by Tai (1971). The results are in broad agreement with earlier findings that linear regression form a predominant portion of genotype X environment interactions in Egyptian wheat (Moussa *et al* 2006).

A perfectly stable genotype do not change from environment to another. According to Tai's theory, the perfectly stable genotype should have α =-1 and λ=1, while genotype of average stability might have estimates of α =0 and λ=1. Because perfectly stable genotypes probably do not exist, plant breeders will have to satisfy with the obtainable levels of stability, *i.e.,* average stability α=0.0 and λ=1, whereas, the values $\alpha > 0.0$ and λ=1.0 will be below average stability and the values $\alpha < 0.0$ and λ=1, as above average stability.

The estimates of the genotypic stability (αi), the linear response of environment effects and (λ1), the deviation from linear response were computed for each of the sixteen wheat genotypes and are presented in Table (5) and graphically potted in Fig (1).

The genotypes Sakha 69, Sakha 8, V. 22, Line 12, Line 13, Line 19 and Line 33 had significant values for grain yield, therefore, they were considered to be unstable.

Table 4. Phenotypic and genotypic stability parameters for grain yield (ard./fed.) of the studied wheat genotypes.

Genotypes	Stability Parameters							Degree of Stability
	$\bar{X}$	bi	S2d	α|	λ	0.99	0.95	0.90
G1 Sakha 93	16.45	1.332**	72.23**	0.329	6.959	+	+	+
G2 Sakha 69	15.234	0.971**	58.24**	-0.025	27.463	+	+	+
G3 Sakha 8	13.924	0.817**	31.06**	-0.186	7.396	+	+	+
G4 Giza 164	15.596	1.362**	71.19**	0.356	0.992	++	++	++
G5 Gemmieza7	17.024	1.236**	61.32**	0.253	4.163	+	+	+
G6 Zarzora1	15.115	1.177**	60.32**	0.186	10.033	+	+	+
G7 V. 21	13.61	1.737**	120.08**	0.737	7.856	+	+	+
G8 V. 22	15.409	0.636**	21.29**	-0.362	7.856	+	+	+
G9 Line 10	12.985	0.853**	28.75**	-0.149	1.721	+	++	++
G10 Line 11	16.203	1.246**	59.99**	0.243	2.126	+	+	+
G11 Line 12	13.495	0.838**	30.19**	-0.158	4.847	+	+	+
G12 Line13	16.186	0.558**	15.97**	-0.451	5.241	+	+	+
G13 Line18	18.729	0.762**	22.59**	-0.24	0.973	+++	+++	+++
G14 Line19	15.99	0.991**	40.57**	-0.011	4.546	+	+	+
G15 Line30	14.79	0.893**	30.90**	-0.109	1.108	++	++	++
G16 Line33	16.255	0.591**	21.33**	-0.413	10.204	+	+	+
Grand mean	14.923							
Standard error	0.1535							

Figure (2) illustrated α and λ distribution of the sixteen wheat genotypes. Genotypes Giza 164 (4), Line 10 (9) and Line 30 (13) had average stability and genotypes Sakha 93 (15), Gemmieza 7 (5), Zarzora 1 (6), V. 21 (7) and Line 11 (10) with below average stability, while genotype Line 18 (13) with above stability. The remained genotypes Sakha 69 (2), Sakha 8 (3), V.22 (8), Line 12 (11), Line 13 (12), Line 19 (14)and Line 33 (16) were unstable as shown in Figure (2). These results are in general agreement with those obtained by Awaad and Aly (2002).

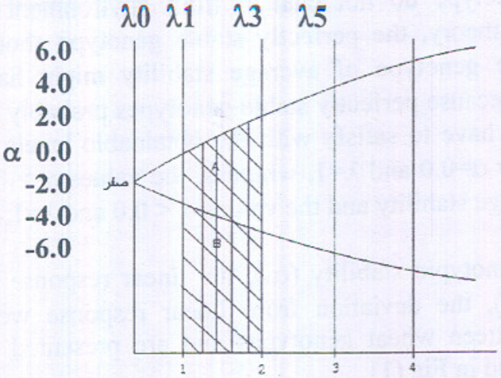

Figure (1): A hypothetical (α) and distribution (λ).
A: Region of average stability. **B: Region of above stability.**

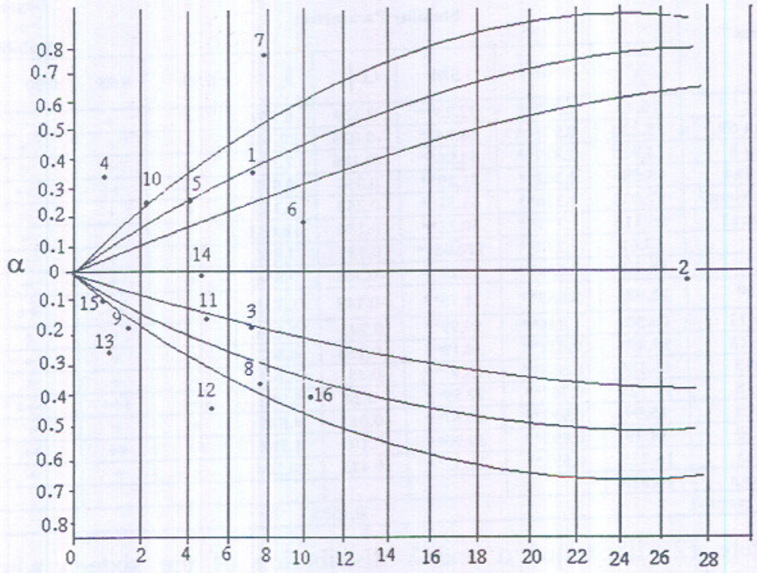

Figure (2): α and λ distribution of the sixteen wheat genotypes.

Yield stability as proposed by Kang (1993)

Genotype x environment (GE) interaction continues to be a challenging issue among plant breeders, geneticists and production agronomists who conduct crop performance trials across diverse environments. An universally acceptable selection criterion that take GE interaction into consideration does not exist. Whenever an interaction is significant, the use of main effect (*e.g.,* overall genotype means across environments) is questionable.

Researchers need a statistic that provides a measure of stability or consistency of performance across a range of environments, particularly one that reflects the contribution of each genotype to the total GE interaction.

Kang developed an interactive BASIC computer program (1988) and a SAS program (1989) for calculating σ_i^2. The σ_i^2 statistic, by it self, is only of limited usefulness. However, to be of practical utility in a breeding or cultivar testing program, σ_i^2 and yield (or any other trait) must be considered simultaneously.

Efforts have been made to combine yield and σ_i^2 into a single selection criterion (Kang and Pham 1991 and Kang 1993).

Recently, Kang (1993) developed a yield stability (YSi) statistic to be used as a selection criterion when GE interaction is significant and to demonstrate the benefit to growers of emphasizing stability of performance during the selection process. Whereas, two computer programs are avialable to calculate σ_i^2, neither computers YSi statistic. They developed a new program to calculate both of σ_i^2 and YSi statistics. This program called STABLE and would be useful for integrating yield and stability as to combine them into a single selection criterion.

Analyses of variance for yield and its components are presented in Table (5). The G X L interaction was found to be significant in no. of grains/spike, 1000 grain weight and grain yield/fed. The partitioning of the genotype X environment interaction variance into components, heterogeneity or non additivity and residual for the four traits studied is also show in Table (5).The residual represents variation after the differential effects of a covariate (differential fertility and cultural practices at different years) has been removed. The residual was found to be significant for all traits studied. Growers would prefer to use a high-yielding genotype that performs consistently from year to year. They may even be willing to sacrifice some yield if they are guaranteed, to some extent, that a cultivar would produce consistently from year to year (Kang and Pham 1991). The guarantee that is a cultivar would perform consistently would be in statistical terms, based on type I and type II error rates for a selection criterion that encompasses both yield and stability. Table (6, 7,) showing

Table 5. Analysis of variance for yield and its components in 16 genotypes of wheat.

S.O.V.	d.f	Mean squares			
		No. of spikes/m2	No. of grains/spike	1000-grain weight	Grain yield
Genotypes	15	18272**	452.8**	24.96**	51.98
Environments	7	102982**	1666.1**	289.8**	310.30**
Interaction	105	2225**	22.31**	6.61**	40.20*
Heterogeneity	15	5741**	105.3**	27.59**	41.68
Residual	90	1638**	8.49**	3.11**	39.95*
Pooled Error	240	217.39	1.386	.823	32.30

Table 6. Simultaneous selection for yield and stability for no. of spikes/m2 and no. of grains/spike in 16 wheat genotypes

No. of spikes/m2							
Rank	No. of grains/spike	Yield Rank	Adjustment to Rank	Adjusted (Y)	Stability variance	Stability Rating	YS (i)
G1 Sakha 93	535.9	8	1	9	2796.9**	-8	1
G2 Sakha 69	586.5	16	3	19	259.9	0	19+
G3 Sakha 8	540.6	11	2	13	3819.3**	-8	5+
G4 Giza 164	540.8	12	2	14	1221.5**	-8	6+
G5 Gemmieza7	489.9	1	-3	-2	829.9**	-8	-10
G6 Zarzora1	494.8	2	-3	-1	2421.2**	-8	-9
G7 V. 21	513.4	6	-3	3	3778.7**	-8	-5
G8 V. 22	534.6	7	1	8	4017.7**	-8	0
G9 Line 10	508.3	5	-3	2	2819.2**	-8	-6
G10 Line 11	499.1	3	-3	0	3011.3**	-8	-8
G11 Line 12	541.1	13	2	15	1517.0**	-8	7+
G12 Line13	569.4	15	3	18	838.9**	-8	10+
G13 Line18	539.1	10	2	12	2720.7**	-8	4+
G14 Line19	502.5	4	-3	1	3942.9**	-8	-7
G15 Line30	536.5	9	1	10	151.51	0	10+
G16 Line33	558.9	14	3	17	1462.2	-8	9+
Mean LSD	530.7 7.0014						1.625
No. of grains/spike							
G1 Sakha 93	54.8375	4	-3	1	21.41**	-8	-7
G2 Sakha 69	55.28	6	-3	3	30.31	-8	-5
G3 Sakha 8	60.035	12	3	15	29.22**	-8	7+
G4 Giza 164	54.71	3	-3	0	6.37**	-8	-8
G5 Gemmieza7	54.3725	2	-3	-1	74.50**	-8	-9
G6 Zarzora1	54.865	5	-3	2	24.26**	-8	-6
G7 V. 21	61.8525	14	3	17	19.85**	-8	9+
G8 V. 22	62.4075	15	3	18	5.30**	-8	10+
G9 Line 10	69.3	16	3	19	14.49**	-8	11+
G10 Line 11	56.91	9	-2	7	18.73**	-8	-1
G11 Line 12	59.3475	11	3	14	23.38**	-8	6+
G12 Line13	58.9075	10	2	12	4.07**	-8	4+
G13 Line18	50.95	1	-3	-2	5.790636	-8	-10
G14 Line19	56.8525	8	-3	5	28.96**	-8	-3
G15 Line30	56.1925	7	-3	4	25.90**	-8	-4
G16 Line33	60.76	13	3	16	24.30**	-8	8+
Mean LSD	57.97 0.559						0.125

Table 7. Simultaneous selection for yield and stability for No. of 1000-grain weight and grain yield (Ard/fed.) in 16 wheat genotypes

1000 Grain weight							
Rank	Yield	Yield Rank	Adjustment to Rank	Adjusted (Y)	stability Variance	Stability Rating	YS (i)
G1 Sakha 93	47.76625	1	-3	-2	1.891*	-4	-6
G2 Sakha 69	47.825	2	-3	-1	2.078*	-4	-5
G3 Sakha 8	51.23625	16	3	19	4.59*	-8	11+
G4 Giza 164	48.88	5	-2	3	9.26*	-8	-5
G5 Gemmieza7	49.77625	11	1	12	23.88**	-8	4+
G6 Zarzora1	50.74875	15	3	18	4.29**	-8	10+
G7 V. 21	50.1	13	2	15	4.27**	-8	7+
G8 V. 22	48.97625	6	-1	5	3.70**	-8	-3
G9 Line 10	49.10125	7	-1	6	19.04**	-8	-2
G10 Line 11	50.3025	14	3	17	2.03*	-4	13+
G11 Line 12	48.15375	3	-3	0	9.40**	-8	-8
G12 Line13	49.68375	9	1	10	2.88*	-8	2
G13 Line18	49.32625	8	-1	7	2.81**	-8	-1
G14 Line19	50.0775	12	2	14	6.28**	-8	6+
G15 Line30	49.7075	10	1	11	7.48**	-8	3+
G16 Line33	48.3575	4	-3	1	1.75*	-4	-3
Mean LSD	49.37 0.430						1.437
Grain yield (ardab/fed)							
G1 Sakha 93	14.79	5	-1	4	8.614 N.S	0	4
G2 Sakha 69	16.255	13	1	14	4.48 N.S	0	14+
G3 Sakha 8	18.72	16	2	18	531.57**	-8	10+
G4 Giza 164	15.98	10	1	11	-.933 N.S	0	11+
G5 Gemmieza7	13.61	3	-1	2	13.79 N.S	0	2
G6 Zarzora1	15.40	8	-1	7	2.20 N.S	0	7
G7 V. 21	15.23	7	-1	6	14.35 N.S	0	6
G8 V. 22	16.45	14	1	15	10.00 N.S	0	15+
G9 Line 10	17.02	15	1	16	22.07 N.S	0	16+
G10 Line 11	15.11	6	-1	5	9.76 N.S	0	5
G11 Line 12	16.18	11	1	12	1.79 N.S	0	12+
G12 Line13	16.20	12	1	13	4.849 N.S	0	13+
G13 Line18	12.98	1	-1	0	2.44 N.S	0	0
G14 Line19	13.49	2	-1	1	-1.11 N.S	0	1
G15 Line30	13.92	4	-1	3	8.53 N.S	0	3
G16 Line33	15.59	9	1	10	10.70 N.S	0	10+
Mean LSD	15.437 2.698						8.062

stability variance (σ_i^2) of yield stability YSi for simultaneous selection for yield and yield components in wheat performance trials. For no. of spikes/m2, the mean (YSi) is 1.625 Table (6). Eight genotypes with YSi ≥ 2 would be selected (2, 3, 4, 11, 12, 13, 15, 16). The mean yield stability of these eight genotypes was 8.75 which is about equal to the mean yield (551.6) spikes of the eight genotypes that would be selected on the basis of conventional method (Selection on the basis of yield alone). The (YSi) statistical (selection on the basis of yield and stability) insured selection of consistently performing varieties more than conventional method.

For no. of grains/spike, the mean (YSi) yield stability 0.125 Table (7). Seven genotypes with YSi ≥ 1 would be selected (3, 7, 8, 9, 11, 12, 16). The mean yield of these seven genotypes was which is about equal to the mean yield (61.8 grain) of the seven genotypes that would be selected or the basis of conventional method (selection on the basis of yield alone yield and stability). The (YSi) (yield and stability statistic) insured selection of consistently performing varieties more than conventional method.

With respect to 1000 grain-weight, the mean (YSi) yield stability is 1.438 (Table 7). Eight genotype with YSi ≥ 2 would be selected as marked by these genotypes are no, 3, 5, 6, 7, 10, 12, 14 and 15. The mean yield of these eight genotypes was which is about equal to the mean yield weight (50.28 g) of the eight genotypes that would be selected on the basis of conventional method (selection on the basis of yield alone. The YSi statistic (selection on the basis of yield and stability) insured selection of consistently performing varieties more than conventional method.

Regarding grain yield/faddan, the mean YSi yield stability is 8.0625. Eight genotypes with YSi ≥ 9 would be selected (genotypes no. 2, 3, 4, 8, 9, 12, 13 and 16 as marked by t). The mean yield of the mentioned eight genotypes was which is about equal to the mean yield (16.56) of the eight genotypes that would be selected on the basis of conventional method i.e. selection on the basis of yield alone. The YSi statistic (selection on the basis of yield and stability) insured selection of consistently performing varieties more than conventional method.

According to Shukla and Kang analysis, it is clear to suggest that the best genotypes which would be selected under the conditions of this experiment are no. 3, 1, 12 and 16. These genotypes characterized by high YSi (selection on the basis of yield and stability) as well as high yielding according to the conventional method (selection on the basis of yield alone).

REFERECES

Allard, F.W. and A.O. Bradshow (1964). Implications of genotype-environmental interactions in plant breeding. Crop Sci., 4: 503-508.

Awaad, H. A. and A. A. Aly (2002). Phenotypic and genotypic stability parameters for grain Yield and its contributing characters in bread wheat *(T. aestivum* L.*)*. Zagazig. J. Agric. Res. 29: 983-997. Egypt.

Backer, H.C.; H.H. Geiger and K. Morgan Sterm (1982). Performance and phenotype. Crop Sci. 22: 340-344.

Badhe, P. L., V. V. Bhavsar and B. B Pawar (1998). Stability parameters in wheat (Triticum SPP.). Annals of Agric Res., 19 (2): 125- 129.

Basiouny, A. H. (1985). Studies on yield potentiality in wheat. Ph. D. Fac. of Agric. Zagazig Univ. Egypt.

Breese, E.L. (1969). Tnemeasurement and significant of genotype-environment interactions in grasses. Heredity, 24: 27-44.

Eberhart, S. A. and W. A. Russell (1966). Stability parameters for comparing varieties. Crop. Sci., (6): 36-40.

EL-**Dafrawy, M. M., K. A. Kheiralla and R. A. Dawood (1994).** Effect of genotype, moisture stress and stability and some quality traits in wheat. Assiut. J. of Agric. Sci, 25 (1): 341-360. Egypt.

Ghandorah, M.O. (1989). Grain yield and its stability of some selected wheat varieties in Saudi Arabia. J. King Saud Univ. Agric. Sci. 1(1-2): 75-85.

Ghanem, E. H., A. M. Abd El-Shafi Ali, N. S. Hanna, S. K. Mahmoud, S. R. Sabry, M. M. Abd El-Aleem, H. M. M. Zaid, A. M. Moussa, S. A. Abd El-Mogeed and S. Sherif (1996). Grain yield and stability of the new bread wheat (Triticum aestivum L.) cultivar Sids 1 in different agroclimatic zones of Egypt. Bull. Fac. Agric. Univ. Cairo, 47: 565 – 576.

Ibrahim, K. I. M. (2004). Genotype X environment interaction and stability analysis for grain yield and its attributes of some promising bread wheat lines. Arab. Univ. J. Agric. Sci. Ain Shams Univ., 12 (1): 163-183. Egypt.

Kang, M. S. (1988). Interactive BASIC program for calculating stability-variance parameters. Agron. J. 80:153.

Kang, M. S. (1993). Simultaneous selection for yield and stability in crop performance trials:: Consequences for growers. Agron. J., 85: 754-757. U.S.A.

Kang, M. S. and H. M. Pham (1991). Simultaneous selection for high yielding and stable crop genotypes. Agron. J., 83: 161-165.

Kang, M.S. (1989). A new SAS program for calculating stability variance parameters. J. Hered. 80: 415.

Kang, M.S. and R. Magari (1995). Stable a BASICA program for calculating stability and yield: stability statistics. Agron. J. 87: 276-277.

Moussa, A. M., H.I. Hendawy and H. A. Ashoush. (2006). Phenotypic stability for some bread wheat genotypes. Minufiya J. Agric. Res., (2006) 31(2): 435-451.

Parada, R.S. and J.D. Hyes (1971). An investigation of genotype environment interaction for rate of ear emergence in spring barley. Heredity 26: 157-175.

Salem. A. H., M. M. Eissa and A. A. Swelam (2002). Genotype-Environment interaction and stability for grain yield and its related characters in bread wheat. Egypt. J. Appl. Sci..17 (11): 141-161. Egypt.

Shukla, G. K. (1972). Some statistical aspects of partitioning genotype x environmental components of variability. Heredity 29: 237-245.

Snedecor, G.W. and W.G. Cochran (1989). Statistical Methods. Iowa State Univ. Press, Ames, V.A. 8th Ed.

Tai, G. C. C. (1971). Genotypic stability analysis and its application to potato regional trials. Crop Sci., (11): 184-190.

تقدير معالم الثبات فى بعض التراكيب الوراثية للقمح تحت ظروف بيئية مختلفة

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أجريت تجربتين حقليتين فى كلية الزراعة – جامعة المنوفية خلال موسمي 2004/2003، 2005/2004 وذلك لدراسة مدى ثبات ستة عشر تركيبه وراثية من القمح الربيعى تحت مستويات مختلفة من الرى (ثلاثة ريات – خمسة ريات) والتسميد النيتروجينى (35، 70 كجم ازوت/فدان) فى تجربة ذات تصميم قطع منشقة مرتين ذو ثلاثة مكررات وتم وضع الرى فى القطع الرئيسية والتسميد فى القطع الفرعية والتراكيب الوراثية فى القطع تحت الفرعية.

وقد تم تحليل معالم الثبات لصفات عدد السنابل فى المتر المربع وعدد الحبوب فى السنبلة ووزن الألف حبه ومحصول الحبوب (أردب / فدان) وذلك بواسطة كل من :-

1- **موديل Eberthart and Russell (1966) للمحصول ومكوناته.**

2- **موديل Tai (1971) لمحصول الحبوب / فدان فقط.**

3- **موديل Kang (1993) للمحصول ومكوناته.**

ويمكن تلخيص أهم النتائج المتحصل عليها كالتالي :-

1- **أظهر التحليل المظهري بطريقة Eberthart and Russell (1966) أن السلالة رقم 19 والسلالة رقم 33 حازت قيماً منخفضة للــ (bi) للصفات المدروسة مما يدل على أن هذه التراكيب الوراثية أكثر ثباتاً تحت الظروف الغير مناسبة بينما أعطت السلالة (1) والصنف جميزه 7 قيما عالية من الــ (bi) لكل الصفات تحت الدراسة مما يدل على أن هذه السلالة أكثر ثباتاً فى الظروف المناسبة.**

2- **أظهرت قيم الثبات الوراثى المقدرة بواسطة موديل Tai (1971) لصفه محصول الحبوب أربعة مجاميع:**

أ- أصناف ذات ثبات وراثي متوسط وهى جيزه 164 ، السلالة رقم 10والسلالة رقم 30 .

ب-أصناف وسلالات ذات ثبات وراثي تحت المتوسط وهى : سخا 93 ، جميزة 7 ، زرزورا 1 والسلالة رقم 21.

جـ- أصناف وسلالات ذات ثبات وراثي أعلى من المتوسط وهى سلاله رقم 18 التى تعتبر أكثر استجابة للظروف البيئية الغير ملائمة.

د- سلالات غير ثابتة وهى سخا 69 والسلالات رقم 22 ، 12 ، 13، 19، 11.

3- **أظهر الثبات المحصولى بطريقة Kang (1993) أن التراكيب الوراثية المنتخبة تحت ظروف هذه التجربة هى السلالات 18، 13، 11 جيزة 164 والتي صنفت على أنها ذات ثبات محصولى عالي.**