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# YIELD STABILITY OF SOME EGYPTIAN NEWLY RELEASED BREAD WHEAT CULTIVARS

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**ABSTRACT:** *The objectives of this study were to identify the differences in grain yield among five newly released bread wheat cultivars namely Sakha 93, Giza 168, Gemmeiza 5, Gemmeiza 7, Gemmeiza 9 and the commercial one Sakha 69, under Delta region conditions. The effect of environments, cultivars by environment interaction on wheat grain yield stability performance and the magnitude of stability of the newly released wheat cultivars.*

*A total number of thirty-six field experiments were carried out on farmer's fields in Delta region during 1999/2000 and 2000/2001 growing seasons, representing North, Middle and South Delta regions. Each experiment included the newly released bread wheat cultivars Sakha 93, Giza 168, Gemmeiza 5, Gemmeiza 7 and Gemmeiza 9 beside the commercial one Sakha 69. The experimental design used was RCB with three replications and plot size was 21.0 $m^2$. Data of grain yield were collected from each plot and were subjected to analysis of variance. Phenotypic and genotypic stability statistics for grain yield were also estimated.*

*Analysis of variance indicated that, over all locations, cultivar Gemmieza 7 gave the highest grain yield. Quallin conditions promoted the yield potential of the six tested cultivars and resulted in the highest means of grain yield.Generally, the new cultivars Sakha 93, Gemmieza 5 and Gemmieza 7 have a god yield potential and good yield stability, since they gave higher grain yield in most locations, followed by Giza 168 and Gemmieza 9. On the other hand, the old cultivar Sakha 69 has lower yield potential and less stability comparing to the others.*

*The regression coefficient indicated that the studied cultivars did not respond similarly to the different environments. Results showed that the interaction between cultivars and environments was significant.*

*The results of stability study revealed that cultivars Sakha 93, Giza 168, Gemmieza 5 and Gemmieza 7 were stable and performed consistently over environments. However, the cultivar Gemmieza 5 had the highest average stability degree (the closer value to zero).*

**Key words** : *Wheat ,Stability , Genotypic stability , Regression analysis*

# INTRODUCTION

Wheat is the most important food cereal crop in Egypt as well as in many other countries. Egypt suffers a great gape between the national production and consumption. So, increasing total wheat grain production is a national goal to meet the increase in wheat consumption resulted from increasing population. The total wheat production could be increased, horizontally, by extending wheat area to the new cultivated land and, vertically, via growing high yielding cultivars and supplementing the recommended cultural practices (Shehab El-Din 1993, Abdel Aleem et al. 1997 and El-Sayed et al. 2000). However, stable wheat cultivars tolerant to different environmental stresses is the ultimate goal of the National Wheat Research Program.

Evaluation of wheat cultivars under different environmental conditions is very important, in breeding program, to identify and select the high yielding ones, which should be resistant to the three wheat rusts and tolerant to such harsh conditions.

Many investigators reported significant differences among wheat cultivars in their response to the environmental conditions and hence, their grain yields (Ismail, 1995, Salem *et. al*, 1990, Shehab El-Din *et. al*, 1999, Mosaad *et. al*, 2000 and Shehab El-Din *et. al*, 2000).Stable cultivars could confront the production convulsions and problems, and hence preserve high level of grain production.

Eberhart and Russel (1966) identified the ideal cultivar as a high yielding one over a wide range of environments. Also, they indicated the stable cultivar is the one which has regression coefficient "b" equal to 1 and mean square deviation from regression "$S^2$ d" equal to zero. On the other hand, Tai (1971) divided the genotype by environment interaction effects of a genotype into two statistic components, i.e. "α" statistic that measures the linear response to the environmental effects and "λ" statistic that measures the deviation from linear response.

The objectives of this study were to identify the effects of environments and cultivar by environment interaction on wheat grain yield, stability performance of wheat grain yield and determining the magnitude of stability of the few Egyptian newly released wheat cultivars comparing to the widely distributed commercial cultivar Sakha 69.

## MATERIALS AND METHODS

Thirty-six field experiments were carried out during 1999/2000 and 2000/2001 growing seasons. The experiments were performed on farmers' fields at Quallin, Dossok (Kaffer El-Skeekh governorate), Talkha, El-Senblawin, El-Mansoura (El-Dakahlia governorate), El-Zarkaa (Demiata governorate), Belbeas, Abo-Kebeer, Deiarb Negme, Abo-Hammad (El-Sharkia governorate), Kotour, El-Mahalla El-Kobra (El-Gharbia governorate), Toukh (El-Kalubia governorate), Menouf (El-Menofia governorate), Damnohor, El-Mahmoudia and Ettai El-Baroud (El-Behera governorate) and Giza (Giza governorate) to represent a wide range of variable environments of North, Middle and South Delta. Each experiment included six cultivars, i.e. Sakha 69 the wide distributed commercial cultivar and the newly released ones Sakha 93, Giza 168, Gemmeiza 5, Gemmeiza 7 and Gemmeiza 9.

The experimental design was Randomized Complete Block design with three replications. The seeds were broadcasted on plots with 21.0 square meter (6m x 30.5m). All experiments were planting during the last week of November in both seasons. Moreover, the recommended cultural practices of growing wheat in each region were followed.

At crop maturity, all plots were manually harvested and mechanically threshed to estimate the grain yield of each plot and adjusted to ardab per faddan. Grain yield data was subjected to analyses of variance for individual environment and all tests of significance were made at the 0.05 probability level according to Snedecor and Cochran (1967).

A combined analysis of variance was also performed over the environments to detect the genotype by environment interaction effects as described by Le Clerg *et al.*, (1966).

Phenotypic and genotypic stability statistics for grain yield per faddan was estimated for the studied six wheat cultivars. Cultivars were considered as fixed variables, whereas environments were considered as random ones. Phenotypic stability was computed as outlined by Eberhart and Russell (1966) as follow:

$$Yij = Mi + bilj + dij$$

Where:

Yij: is the mean yield of the I th cultivar at the j environment (I= 1,2,3...v and J = 1,2...n).

Mi: is the mean of I th cultivar over all environments.

bi: is the regression coefficient of the measured response of the I th cultivar to varying environments.

Ij: is the environmental index obtained as the mean of all varieties at the j th environment minus the grand mean.

dij: is the deviation from regression of the I th cultivar at the j th environment.

Furthermore, the two stability statistics namely "b" the regression coefficient of the performance of each variety under different environments on the environmental means overall genotypes and "$S^2d$" the mean square deviation from linear regression were calculated .

The ideal cultivar must be characterized by three characteristics

1- Regression coefficient should significantly different from zero ($b \neq 0$) and not significantly differed from unity ($b = 1$).

2-Minimum value of the deviation is about the regression, i.e. $S^2d = 0$

3-High performance within a reasonable range of environmental variations.

Genotypic stability analysis was performed according to Tai (1971), who partitioned genotype by environment interaction effect of the I th cultivar into the two statistics $\alpha_i$ and $\lambda_i$. These statistics were computed and graphically illustrated for each cultivar to compare the relative stability of cultivars where $\alpha_i$ statistic measures the linear response to environmental effects and $\lambda_i$ measures deviation from linear response in terms of the magnitude of the error variance.

The values $\alpha_i = -1$ and $\lambda_i = 1$ will be referred as perfect stability, while the values $\alpha_i = 0$ and $\lambda_i = 1$ will be referred as average stability, whereas the values $\alpha_i > 0$ and $\lambda_i = 1$ are pointing out to below average stability and the values $\alpha_i < 0$ and $\lambda_i = 1$ are above average.

## RESULTS AND DISCUSSION

Obtained data for wheat grain yield in each season was separately analyzed. The same trends were observed. Therefore, the combined analysis of variance was calculated and the average grain yield for the two studied seasons will be discussed. Combined analysis of variance for grain yield of tested wheat cultivars is presented in Table 1. Highly significant differences among cultivars were detected, indicating the presence of genetic variability among these cultivars. Also highly significant mean squares for cultivars x locations, cultivars x years and cultivars x locations x years were detected. These significant mean squares indicating that the tested cultivars carried genes with different additive and additive-by-additive effects, which seemed to be inconstant from environment to another.

The observed significant differences among cultivars in grain yield and their inconstant response to different environments may suggest that it is essential to determine the degree of stability for each cultivar. Moreover, the highly significant effects of locations and locations x years indicated that, environmental components (years and locations) were sufficient to obtain reliable information about the studied wheat genotypes. Similarly, Shehab El-Din (1993), Ismail (1995) and Hassan (1997) detected significant environmental effects on the yielding ability of some wheat genotypes.

**Table 1: Combined analysis of variance for grain yield (ardab/faddan) of six wheat cultivars.**

| Sources of Variation | Degrees of Freedom | Mean square |
|---|---|---|
| Years | 1 | 1149.255** |
| Locations | 17 | 142.173** |
| Years x Locations | 17 | 74.833** |
| Replication / (locations x years) | 72 | 3.846 N.S |
| Cultivars | 5 | 30.388** |
| Years x Cultivars | 5 | 25.292** |
| Locations x Cultivars | 85 | 11.560** |
| Years x Locations x Cultivars | 85 | 8.271** |
| Error | 360 | 3.191 |
| Total | 647 | ** P> 0.01 |

Wheat grain yield in terms of ardab/faddan as affected by locations and cultivars over the two growing seasons is presented in Table 2. Results indicated that locations had significantly affected grain yield which obtained for all tested cultivars. However, the highest grain yields (24.05, 21.74 and 20.89 ardab/faddan) were obtained from Quallin, Dessok and El-Giza locations, respectively, and significantly differed from the other environments. On the other hand, El-Mansoura and El-Zarka locations gave the lowest grain yields (Table 2).The detected significant difference among locations may be due to the different climatic and soil conditions of these locations. These results are in general agreement with those obtained by Sharma et al., (1987) and El-Morshidy *et al.*, (2001).

In general, there were significant differences among cultivars. However, Gemmeiza 7 followed by Gemmieza 5 gave the highest grain yield (19.38 and 19.25 ardab/faddan), while Sakha 69 ranked the last one over all locations and produced 18.03 ardab/faddan.

The highest grain yield of Gemmieza 7 may be attributed to its genetic constitution and it is a high yielding potentiality, rusts resistant cultivar, adapted and recommended to be grown under Delta agro climatic zone conditions (Shehab El-Din *et al.*, 2000). In contrary, the lowest grain yield of Sakha 69 may be due to its susceptibility to the three wheat rusts (stripe, leaf and stem rust).

Moreover, Quallin location conditions promoted the yield potential of the six tested cultivars and hence gave there highest means of grain yield (Table 2). On the other hand, the four cultivars Sakha 69, Sakha 93, Giza 168 and Gemmieza 9 showed their lowest significant grain yield under El-Mansoura conditions, while the other two were lowest under El-Zarka conditions. In general, the highest grain yield (28.16 ardab/faddan) was obtained from the cultivar Sakha 93 at Quallin , while Sakha 69 at El-Mansoura gave the least grain yield (12.12 ardab/faddan). These results clearly indicated that the effect of the interaction between genotype and environment on grain yield is occurred. Roy and Murty (1970) and El-Morshidy *et al.* (2001) obtained similar results.

Table 2: Mean values of grain yield (ardab/faddan) as affected by locations and cultivars (combined analysis of 1999/2000 and 2000/2001 seasons).

| Location | Cultivar | | | | | | Average |
|---|---|---|---|---|---|---|---|
| | Sakha 69 | Sakha 93 | Giza 168 | Gemmieza 5 | Gemmieza 7 | Gemmieza 9 | |
| Quallin | 24.50 | 28.16 | 22.21 | 24.27 | 23.33 | 21.93 | 24.07 |
| Dossok | 23.33 | 21.23 | 18.68 | 20.07 | 20.12 | 21.85 | 20.88 |
| Talkha | 16.70 | 19.74 | 18.00 | 17.22 | 17.00 | 16.54 | 17.53 |
| El-Senblawin | 16.79 | 18.13 | 17.12 | 17.41 | 17.47 | 18.47 | 17.56 |
| El-Mansoura | 12.12 | 13.66 | 15.54 | 19.16 | 16.62 | 15.16 | 15.38 |
| El-Zarkaa | 19.15 | 18.67 | 16.40 | 14.70 | 15.05 | 16.22 | 16.69 |
| Belbeas | 18.29 | 19.04 | 19.21 | 20.89 | 22.43 | 17.82 | 19.61 |
| Abo-Kebeer | 18.29 | 16.27 | 17.16 | 20.62 | 21.17 | 18.61 | 18.68 |
| Deiarb-Negme | 16.91 | 17.36 | 16.45 | 17.71 | 18.69 | 19.04 | 17.69 |
| Abo-Hammad | 17.43 | 19.46 | 18.55 | 19.32 | 19.42 | 17.78 | 18.66 |
| Kotour | 17.93 | 18.20 | 20.35 | 20.02 | 21.11 | 19.80 | 19.57 |
| El-Mahalla | 15.05 | 18.90 | 19.37 | 19.14 | 20.07 | 18.97 | 18.58 |
| Toukh | 17.80 | 20.34 | 20.25 | 20.28 | 20.15 | 17.98 | 19.47 |
| Memouf | 18.19 | 15.65 | 18.34 | 19.14 | 19.00 | 16.22 | 17.76 |
| Damnohor | 16.52 | 17.18 | 17.51 | 17.66 | 17.37 | 17.06 | 17.22 |
| El-Mahmoudia | 16.69 | 18.22 | 17.67 | 18.40 | 18.68 | 18.42 | 18.01 |
| Ettai El-Baroud | 17.84 | 18.96 | 19.34 | 18.80 | 18.89 | 18.52 | 18.73 |
| Giza | 21.10 | 23.01 | 22.28 | 21.70 | 22.28 | 20.07 | 21.74 |
| Average | 18.03 | 19.01 | 18.58 | 19.25 | 19.38 | 18.36 | 18.77 |
| L.S.D. 0.05 | | | | | | | |
| Cultivar | | | | | | 2.03 | |
| Location | | | | | | 0.83 | |
| Cultivar x Location | | | | | | 0.48 | |

Results in Table 2 indicated that the cultivar Sakha 93 was the highest in grain yield at six locations (Quallin, Dossok ,Talkha, Abo-Hammad, Toukh and Giza) and was the lowest one at three locations (Abo-Kebeer,El-Mansoura , and Menouf). The two cultivars Giza 168 and Gemmeiza 9 ranked first in two locations and came lately in three and four locations, respectively, while Gemmeiza 5 and Gemmeiza 7 occupied the first place at three and five locations, respectively. Gemmeiza 5 gave the lowest grain yield at only one location but Gemmeiza 7 never ranked the last. However, the cultivar Sakha 69 was the highest in grain yield at only two locations and was the latest at eight locations. Generally, Sakha 93, Gemmieza 5 and Gemmieza 7 showed insignificant differences in their average grain yield under all environments.

These results could indicate that Sakha 93 has a good yield potentiality but may be, relatively, affected by locations, Giza 168 and Gemmieza 9 have a good stability, while the high level of stability was in favor of Gemmieza 5 and Gemmieza 7. Also, Sakha 69 has lower yield potential and less stability in compare to the other studied newly released cultivars. Shehab El-Din *et al.* (1999), Mosaad *et al.* (2000) and Shehab El-Din *et al.* (2000) reported that the new released wheat cultivars Sakha 93, Giza 168, Gemmieza 7 and Gemmieza 9 are high yielding cultivars tolerant to wheat rusts and highly recommended to replace the commercial cultivars Sakha 69 and Sakha 61 at Delta region.

## Regression analysis

The mean squares of linear regression analysis of variance for grain yield of the six wheat cultivars grown under thirty-six environments are shown in Table 3. Results showed that interaction between cultivars and environments were highly significant. Also, the observed significant deviation mean square, revealed that the cultivars differed significantly in respect to their deviation from the respective average linear response (Salem *et al.*, 2000).

Table 3: Mean squares of analysis of variance for cultivars, environments and cultivars by environments interaction for grain yield (ardab/faddan).

| Source of variation | Degrees of freedom | Mean square |
|---|---|---|
| Total | 215 | 11.449 |
| Cultivars | 5 | 23.920** |
| Environment+(Genotypes x Environments | 210 | 11.152** |
| Environments (Linear) | 1 | 1564.820** |
| Genotypes x Environments (linear) | 5 | 7.336** |
| Pooled deviation | 204 | 3.629** |
| Sakha 69 | 34 | 5.522** |
| Sakha 93 | 34 | 3.162** |
| Giza 168 | 34 | 1.266 |
| Gemmieza 5 | 34 | 3.897** |
| Gemmieza 7 | 34 | 2.979** |
| Gemmieza 9 | 34 | 4.948** |
| Pooled error | 432 | 0.886 |

The significant interaction between cultivar and environment reflected that grain yield of the tested cultivars were more sensitive to the changes in the environments, Kheirall and Ismail, 1995 and Mishra and Chandraker, 1992,came to the same results.

## Stability parameters

Paroda and Hayes (1971) indicated that the linear regression could simply be as a measure of response of a particular cultivar in a particular environment. Also, Breese (1969) reported that cultivars with regression coefficient values greater than one would be adapted to more favorable environments, while those with values less than one would be relatively better adapted to less favorable growing conditions. Therefore, the stability parameters and linear regression were assessed.

## Phenotypic stability

The phenotypic stability parameters of grain yield for the six studied cultivars are presented in Table 4. The results showed clearly that regression coefficient "b" values of all cultivars were significantly different from zero. However, the cultivar Sakha 69 gave the highest "b" value expressing its high instability. This could be due to its susceptibility to wheat rusts. On the other hand, all cultivars, except Sakha 69, were responsive to the environments, and showing regression slope "b" not differed from unity (b=1), indicating wide adaptability over all environments under study. These results are in general agreement with Eberhart and Russel (1966) who defined an ideal cultivar as the cultivar of the highest yield over a wide range of environments with a regression coefficient value of one and deviation from regression close to zero as possible ($S^2d = 0$).

Table 4: Estimates of phenotypic stability for mean grain yield (ardab/faddan) of six wheat cultivars.

| Genotype | Mean grain yield | "b" | "$S^2d$" | "$t_{b-1}$" | "$t_{b-0}$" |
|---|---|---|---|---|---|
| Sakha 69 | 18.03 | 1.229 | 4.637** | 1.573 | 0.447 |
| Sakha 93 | 19.01 | 1.047 | 2.276** | 0.427 | 9.509** |
| Giza 168 | 18.58 | 1.098 | 0.381 | 1.406 | 15.753** |
| Gemmieza 5 | 19.25 | 1.008 | 3.012** | 0.065 | 8.249** |
| Gemmieza 7 | 19.38 | 0.854 | 2.094** | -1.366 | 7.989** |
| Gemmieza 9 | 18.36 | 0.765 | 4.062** | -1.707 | 5.555** |

## Genotypic stability

Genotypic stability statistics, i.e. α (the linear response to environmental effects) and λ (the deviation from linear response) were estimated for each of the six wheat genotypes for grain yield according to the model outlined by Tai (1971). These statistics are shown in Table 5 and graphically illustrated in Fig. 1. The values $\alpha = -1$ and $\lambda = 1$ will be referred as perfect stability and the values $\alpha = 0$ and $\lambda = 1$ will be referred as average stability, whereas the values $\alpha > 0$ and $\lambda = 1$ as below average stability and the values $\alpha < 0$ and $\lambda = 1$ as above average stability.

Table 5 and Fig. 1 showed that cultivar Gemmeiza 5 had an average stability degree (α) of 0.005, the closer value to zero, and gave higher average grain yield of 19.25 ardab/faddan (Table 2). The cultivars Giza 168 and Gemmeiza 7 were spotted in the below average stability area with $\alpha = 0.049$ and 0.034, respectively, whereas Gemmieza 9 spotted in the above average stability area with $\alpha = -0.338$. Cultivars Sakha 69 and Sakha 93 hade λ value out of the range (Table 5 and Fig. 1.).

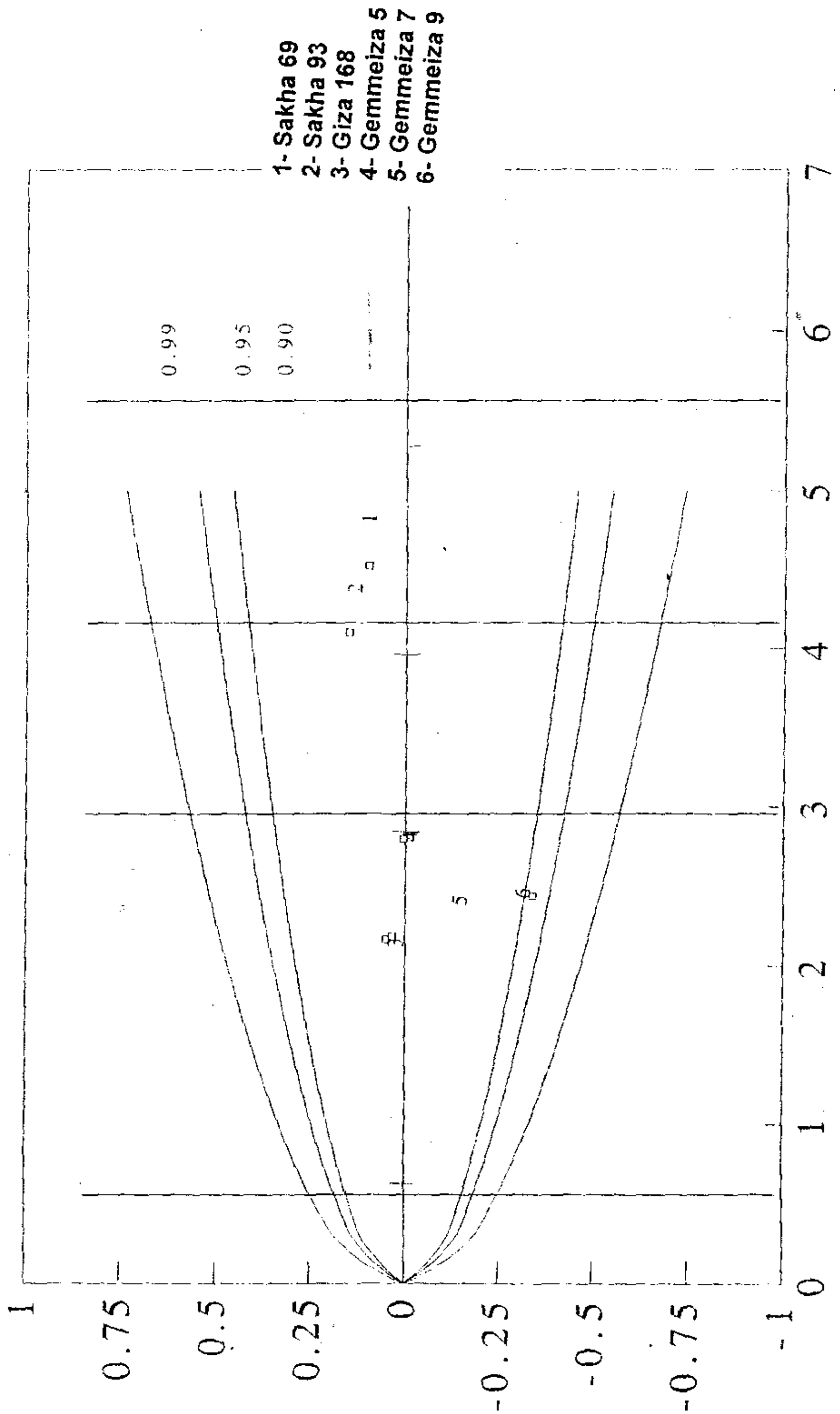


**Fig. (1) : Distribution of stability statistics for yield of wheat genotypes**

Table 5: Parameters of genotypic stability for grain yield of six wheat cultivars.

| Genotype | (α) | (λ) | (b-1) | (dev/mse/p) |
|---|---|---|---|---|
| Sakha 69 | 0.098 | 4.519 | 0.229 | 0.153 |
| Sakha 93 | 0.151 | 4.096 | 0.047 | 8.784 |
| Giza 168 | 0.049 | 2.167 | 0.098 | 0.035 |
| Gemmeiza 5 | 0.005 | 2.795 | 0.008 | 0.108 |
| Gemmeiza 7 | 0.034 | 2.189 | -0.146 | 0.083 |
| Gemmeiza 9 | -0.338 | 2.439 | -0.235 | 0.137 |

These findings agreed Eberhart and Russell statistics for the cultivars Giza 168, Gemmeiza 5 and Gemmeiza 7.

The two estimates of phenotypic stability statistics (b-1) and (dev./mse/p) derived from regression analysis of stability and their genotypic counter parts are also given in Table 5. The absolute estimate values of (b-1) were slightly smaller than α values, while the estimate values of (dev.ms/mse/p) were slightly larger than λ values. This could be due to the relatively large number of environments. This result is in harmony with those obtained by Salem *et al.*, (1990),Abul-Naas *et al* (2000) and Afiah (2001).

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# الثبات المحصولي لبعض أصناف القمح المصرية المستنبطة حديثا

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## الملخص العربي

كان الهدف من هذا البحث هو دراسة الثبات الظاهري والوراثي لمحصول الحبوب لخمسة أصناف من قمح الخبز المستنبطة حديثا وهى سخا ٩٣، جيزة ١٦٨، جميزة ٥، جميزة ٧ وجميزة ٩ مقارنة بمحصول حبوب الصنف التجاري سخا ٦٩، وكذلك دراسة التأثير البيئي والتفاعل بين الأصناف و البيئة على محصول الحبوب، كما يهدف البحث أيضا إلى دراسة الثبات الوراثي لتلك الأصناف. وفى هذا الصدد أقيمت ٣٦ تجربة حقلية في حقول المزارعين بالدلتا خلال موسمي الزراعة ١٩٩٩/٢٠٠٠ و ٢٠٠٠/٢٠٠١، تمثل في مجموعها ٣٦ مركزا مختلفا من مراكز الوجه البحري لتمثل مناطق شمال ووسط وجنوب الدلتا، واستعمل تصميم القطاعات الكاملة العشوائية في ٣ مكررات وكانت مساحة القطعة التجريبية ٢١,٠ مترا مربعا، وتم تطبيق كافة المعاملات الزراعية الموصى بها لكل منطقة، وعند الحصاد تم تقدير محصول الحبوب من جميع التجارب وأجرى التحليل الإحصائي وتقدير الثبات المحصولي للأصناف تحت الدراسة.

أظهرت النتائج أن الصنف جميزة ٧ أعطى أعلى محصول حبوب، ومن ناحية فقد ساعدت الظروف البيئية في موقع "قلين" بمحافظة كفر الشيخ على رفع الكفاءة الإنتاجية للأصناف تحت الدراسة وسجل هذا الموقع أعلى محصول. وبصفة عامة فقد أظهرت الأصناف سخا ٩٣، جميزة ٥ و جميزة ٧ كفاءة وثبات محصولى عالي، حيث كانت أعلى الأصناف محصولا تحت معظم الظروف البيئية المدروسة، وقد تلتها الأصناف جيزة ١٦٨ وجميزة ٩، وكان الصنف التجاري سخا ٦٩ أقلها محصولا وثباتا.

كما أظهرت النتائج أيضا أن الأصناف تحت الدراسة قد تباينت في استجابتها لمختلف الظروف البيئية، حيث كان هناك تأثيرا معنويا للتفاعل بين الأصناف والمواقع على محصول الحبوب. وأظهرت نتائج تحليل الثبات، بصفة عامة، أن أكثر الأصناف ثباتا تحت الظروف البيئية المدروسة كانت سخا ٩٣، جيزة ١٦٨، جميزة ٥ وجميزة ٧، وبصفة خاصة فقد أظهر الصنف جميزة ٥ أعلى درجة ثبات حيث كانت قيمة انحراف الانحدار أقرب إلى الصفر.