ESTIMATION OF GENETIC VARIANCE FOR YIELD AND
YIELD COMPONENTS IN TWO BREAD WHEAT CROSSES
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ABSTRACT

Two experiments were designed at Etay El-Baroud Agricultural Research
Station during four successive seasons, from 2002/2003 to 2005/2006 seasons. The
crosses evaluated were i.e., Sakha 93 x Davon-2 and Giza 168 x Gemmeiza 9. Five
populations (P1, P2, F1, F2 and F3) were used in this concern.
Significant F2 mean values were obtained for all studied traits in both two crosses.
Then, various biometrical parameters in this study could be estimated.
Significant positive heterotic effects towards better parents were detected in each of
100-kernel weight and grain yield/plant in the two studied crosses and only for number
of kernels/spike in the first cross.

Over dominance towards highest parent was obtained for all studied traits in
both two crosses except for number of spikes/plant in the first cross whereas partial
dominance was resulted. On the other hand, complete dominance towards the
highest parent value was shown for number of kernels/spike in the second cross.
Inbreeding depression estimates were found to be significantly positive in the first
cross for number of spikes/plant, number of kernels/spike and grain yield/plant. The
same direction was obtained only in the second cross for 100-kernel weight.
Additive type of gene effect resulted that, it was significant positive in the second
cross for number of spikes/plant, number of kernels/spike and grain yield/plant.
Meantime, dominance gene effect showed that most of studied traits in both crosses
were significantly positive.

Heritability as a broad sense gave high value estimates and significant for all
studied traits in both two crosses while heritability as a narrow sense showed the
same direction except for number of spikes/plant and number of kernels/spike in
the first cross whereas estimated low values.
Additive and additive X dominance type of gene action showed significant for 100-
kernel weight. On the other hand, dominance X dominance (e) type of gene effect
had an important role in the inheritance of number of kernels/spike. Also, plant
breeder can depends on the expected values when make the selection that it were
approximately equal to the actual one.

The obtained results indicated that the selection for the studied traits may be
actually in the early generation but it may be more effective if past poned to late one.
Also, these study concluded that, it can be take in consideration the second cross (Giza 168 x Gemmeiza 9) to improve the breeding program in the National Wheat
Research Program.

INTRODUCTION

In Egypt, wheat (Triticum aestivum L) is the most important cereal
crop. However, the gap between the local production and consumption is
continuously increase due to increasing the country population with limited
cultivated area. Wheat breeders are always looking for mean and sources of
genetic improvements in grain yield and its components and in other
agronomic characters.
The Egyptian wheat cultivars have somewhat narrow genetic background. Hybridization between the Egyptian wheat cultivars and exotic materials may be carried out to increase the genetic variability. Knowledge of the genetic relationship among individuals or populations is essential to breeders for planning crosses to gain better selections for high yielding and developing new promising lines.

Abul-Naas et al. (1991) and Al-Kaddoussi et al. (1994) reported that, dominance component of gene action played an important role in the genetic control for, number of spikes/plant, number of kernels/spike, 100 kernel weight and grain yield/plant. On the other hand, Crumpacker and Allard (1962) reported that, the efficiency in breeding of self-pollinating crop plants depended firstly, on accurate identification of hybrid combinations that had the potentiality of producing maximum improvements and secondly, on identifying, in early segregating generations, the superior lines among the progeny of the most promising hybrids. Therefore, maximum progress in improving a character would be expected with a carefully designed pedigree selection program when the additive gene action is the main component.

El-Hosary et al. (2000) found that, grain yield and its components in diallel cross mating among eight parents, were controlled by both, additive and non-additive gene effects. In addition, concerning the heritability as narrow sense, Gouda et al. (1993) showed that, it was ranged from 14 to 71 % for grain yield. Moustafa (2002), Hondawy (2003), El-Sayed (2004) and Abdel-Nour et al. (2005) reported that heritability estimates for yield and its components were medium to high.

This work was conducted to study the genetic variance, gene action, heritability and comparison between actual and expected genetic gain of two bread wheat crosses derived from four parental bread wheat genotypes using five populations of each cross.

MATERIALS AND METHODS

Two crosses were used in the present study derived from four wide diverse parental bread wheat cultivars. The names, pedigree and origin of these parental genotypes are given in Table (1). These genotypes were used to obtain the following two crosses; Sakha 93 × Dovin 2 and Giza 168 × Gemmiza 9 to study the yield and its main components i.e., number of spikes/plant, number of kernels/spike, 100-kernel weight (g) and grain yield/plant (gm).

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Pedigree</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sakha 93</td>
<td>Sakha 92/TR810328&lt;br&gt;S8871-1s-2s-1s-0s.</td>
<td>EGYPT</td>
</tr>
<tr>
<td>Dovin 2</td>
<td>CM84665-02AP-300AP-300L-3AP-300L-3AP-OL-QAP</td>
<td>ICARDA</td>
</tr>
<tr>
<td>Giza 168</td>
<td>MRL/BUC/SERI&lt;br&gt;CMB93046-8M-OM-2Y-OB-OGZ.</td>
<td>EGYPT</td>
</tr>
<tr>
<td>Gemmiza 9</td>
<td>ALD'S°/HUAC CMH74A.630/SX.&lt;br&gt;CGM 4583-5GM-1GM-OGM</td>
<td>EGYPT</td>
</tr>
</tbody>
</table>

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The experimental work of the present study was carried out at Etay El-Baroud Agricultural Research Station, El-Behera Governorate, during four successive seasons from 2002/2003 to 2005/2006. In the first season (2002/2003), the parental genotypes were crossed to obtain F1 seeds. In the second season (2003/2004), the hybrid seeds of the two crosses were sown to give F1 plants, at the same time, these plants were selfed to produce F2 seeds. Moreover, the same parents were crossed to have F1 seeds. The new hybrid seeds and part of seeds whereas obtained from F1 selfed plants (F2 seeds) were kept in refrigerator to planted in the final experiment. In the third season (2004/2005), two F1 hybrid seeds were sown to produce F1 plants, each of F1 plants was selfed to produce F2 seeds. In addition, F1 and F2 plants were selfed to produce F2 and F3 seeds, respectively. In the fourth season (2005/2006), the obtained seeds for the five populations (P1, P2, F1, F2, and F3) of the two crosses were evaluated using randomized complete block design with three replications. The experimental unit was two rows for each of parents and F1 progenies totaling 20 plants from each of them. 20 rows for F2 generation totaling 200 plants and five rows for F3 families totaling 50 plants. Each row was 2m. long and 20cm. apart between rows. The plants within the same row were 10cm. apart. The data were recorded on an individual guarded plants for number of spikes/plant, number of kernels/spike, 100 kernel weight (g) and grain yield/plant (g).

Various biometrical parameters in this study would only be calculated if the F2 genetic variance was found to be significant. In this concern, F2 genetic variance were found to be significant. Heterosis % was expressed as percentage deviation of F1 mean performance from better parent values (heterobetiosis). Potence ratio (P) was also calculated according to Peter and Frey (1966). Inbreeding depression % was calculated as the difference between the F1 and F2 means expressed as percentage of the F1 mean.

The estimates of mean effect parameter (m), additive-additive x dominance (d), dominance (h), dominance x dominance (e) and additive x additive (i) were obtained by five parameters model illustrated by Hayman model according to Singh and Chaudhary (1985).

Heritability was calculated as both broad and narrow senses according to Mather's procedure (1949) and parent off-spring regression according to Sakai (1960). On the other hand, the expected and actual genetic advance (AG) was computed according to Johensen et al. (1955). Similarly, the genetic gain percentage of the F2 and F3 mean performance (AG %) was estimated using the method of Miller et al. (1958).

RESULTS AND DISCUSSION

The choice of the parents to be used in crossing in breeding programs are the most important problem facing the breeder. If the parents are precisely selected. The desired recombinations will be found in the segregated generations (Mahrous, 1998). Parental differences in response to their genetic background were found to be significant in most characters.
under investigation. The F₂ populations were also significant for all studied characters in the two crosses. Thus, different biometrical parameters used in this study were estimated. Means and variances of five populations i.e., (P₁, P₂, F₁, F₂, and F₃) for the studied characters in two crosses are presented in Table (2). Heterosis, potence ratio (P), inbreeding depression percentage and different gene actions for the four studied characters are given in Table (3).

In self pollinated crops such as wheat, plant breeders have been investigated the possibility of developing hybrid cultivars. The feasibility of growing hybrid cultivars depends on the economic production of large quantitative of hybrid seeds and significant superiority in yield as well as best performance of hybrids compared to the current commercial cultivars (Mahrous, 1998). On the other hand, heterosis over better parent may be useful in identifying the best hybrid combinations but these hybrids can be immense practical value if they involve the best cultivar of the area (Prasad et al., 1998).

Significant positive heterotic effect was found for all characters except for number of spikes/plant in the first and second crosses and, for number of kernels/spike in the second cross where it was significantly negative. These results are similar as those reported by Moshref (1996) Hendawy (1998), El-Hosary et al. (2000), Moustafa (2002), Hendawy (2003), El Sayed (2004), Abdel-Nour Nadya et al. (2005), Abdel-Nour, Nadya and Moshref (2006).

Number of spikes/plant, number of kernels/spike and 100 kernel weight are the main components of grain yield. So, increasing heterosis, if it found in one or more of these attributes may be lead to favorable yield increasing in hybrid.

The absence of significance in heterosis for number of spikes/plant in the first and second crosses may be due to the lower magnitude of the non additive gene action. These results are in agreement with Keteta et al. (1976) and El-Rassas and Mitkess (1985). The pronounced heterotic effect for 100 kernel weight in the first cross (Sakha 93 x Dovin 2) and second one (Giza 168 x Gemmiza 9) may be take in consideration in a breeding program for high yielding ability by selecting for this character.

Potence ratio (P) whereas indicated the overdominance was resulted for all studied characters except for, number of kernels/spike in the second cross which showed complete dominance towards the higher parent. On the other hand, number of spikes/plant showed partial dominance in first cross. These results are in agreement with those obtained by Rady et al. (1981), Moustafa (2002), Hendawy (2003), Al-Kaddoussi et al. (1994), Mosaad et al. (1990) and Abdel-Nour, Nadya and Moshref (2006).

Inbreeding depression values obtained in the two crosses illustrated that all studied characters show significant values except for, number of spikes/plant, number of kernels per spike and grain yield per plant in the second cross. On the other hand, 100 kernel weight in the first cross significant negative inbreeding depression value was detected.
Table (2): Means (x) and variances (s²) for the studied characters using the five Populations for the two bread wheat crosses.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Parameters</th>
<th>Sakha 93 x Dovin 2</th>
<th>Giza 168 x Gemmize 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P₁</td>
<td>P₂</td>
</tr>
<tr>
<td></td>
<td>s²</td>
<td>5.79</td>
<td>6.51</td>
</tr>
<tr>
<td>Number of kernels/spike</td>
<td>x</td>
<td>73.10</td>
<td>81.90</td>
</tr>
<tr>
<td></td>
<td>s²</td>
<td>10.90</td>
<td>27.92</td>
</tr>
<tr>
<td>100 kernel weight (g)</td>
<td>x</td>
<td>4.46</td>
<td>4.58</td>
</tr>
<tr>
<td></td>
<td>s²</td>
<td>0.40</td>
<td>0.61</td>
</tr>
<tr>
<td>grain yield/plant (g)</td>
<td>x</td>
<td>59.90</td>
<td>64.50</td>
</tr>
<tr>
<td></td>
<td>s²</td>
<td>11.25</td>
<td>22.41</td>
</tr>
</tbody>
</table>

Table (3): Heterosis, potence ratio, inbreeding depression and gene action parameters for the two bread wheat crosses.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Cross</th>
<th>Heterosis % over B.P</th>
<th>Potence ratio (P)</th>
<th>Inbreeding depression</th>
<th>m</th>
<th>d</th>
<th>h</th>
<th>e</th>
<th>l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of spikes/plant</td>
<td>I</td>
<td>-1.07**</td>
<td>0.64</td>
<td>13.21**</td>
<td>21.22**</td>
<td>-1.25**</td>
<td>-2.033</td>
<td>15.98**</td>
<td>-5.334*</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>7.06</td>
<td>3.50</td>
<td>6.86</td>
<td>21.08**</td>
<td>0.555*</td>
<td>7.567**</td>
<td>-4.09*</td>
<td>6.672**</td>
</tr>
<tr>
<td>Number of kernels/spike</td>
<td>I</td>
<td>13.92**</td>
<td>20.75**</td>
<td>23.58</td>
<td>71.10**</td>
<td>-0.06</td>
<td>0.977**</td>
<td>-3.053**</td>
<td>0.427**</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>-15.64**</td>
<td>1.24</td>
<td>-0.04</td>
<td>67.98**</td>
<td>2.20**</td>
<td>9.853*</td>
<td>-12.107</td>
<td>7.234*</td>
</tr>
<tr>
<td>100 kernel weight (g)</td>
<td>I</td>
<td>8.08**</td>
<td>1.167</td>
<td>-5.56**</td>
<td>5.23**</td>
<td>-4.46**</td>
<td>24.93**</td>
<td>38.933**</td>
<td>0.334</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>7.17**</td>
<td>3.25</td>
<td>2.04**</td>
<td>5.27**</td>
<td>-0.28**</td>
<td>-1.1**</td>
<td>2.64**</td>
<td>-2.3**</td>
</tr>
<tr>
<td>grain yield/plant (g)</td>
<td>I</td>
<td>9.302**</td>
<td>3.09</td>
<td>10.00**</td>
<td>63.45**</td>
<td>-2.3**</td>
<td>5.233</td>
<td>17.733</td>
<td>-7.667</td>
</tr>
</tbody>
</table>

* and ** significant at 0.05 and 0.01 probability levels, respectively.
These results, since the expression of heterosis in the F₁, may be followed by reducing in F₂ performance. The obtained results for most crosses were in harmony with those obtained by Khalifa et al. (1997). Significant positive heterosis and significant inbreeding depression were obtained for grain yield/plant and for number of kernels per spike in the first cross and for 100-kernel weight in the second one. On the other hand, significant positive heterosis and significant negative inbreeding depression for 100-kernel weight in the first cross were detected. The contradiction between heterosis and inbreeding depression estimates values may be due to the presence of linkage between genes in these materials, Van der Veen (1959).

The choice of the most effective breeding procedures depends to a large extent on the knowledge of the genetic system contributing the selected characters. Therefore, the nature of gene action was also computed by using five parameters analysis (Hayman model) according to Singh and Chaudhary (1985) and presented in Table (3).

The estimated mean effects of F₂ (m), which reflects the contribution due to overall means plus the locus effects and interactions of the fixed loci, was found to be highly significant for all the studied characters. Additive gene effect (a*) was positively significant for; number of spikes/plant, number of kernels/spike and grain yield/plant in the second cross. On the other hand, (d*) was negatively significant for; number of spikes/plant, and grain yield/plant in the first cross and for 100 kernel weight in the two studied crosses. These results suggested that, the potential for obtaining further improvement for the former characters could be realized by applying pedigree selection program. These results were greatly agreed with those obtained by Amaya et al. (1972), Hendawy (1998), El Hossary et al. (2000), Moustafa (2002), Hendawy (2003), El Sayed (2004), Abdel-Nour, Nadya and Moshref (2006).

Dominance gene effect (h) was significantly positive for number of kernels/spike in the two crosses, and for number of spikes/plant and grain yield/plant in the second cross only. The same direction was detected for 100 kernel weight in the first cross. On the other hand, 100 kernel weight showed significantly negative (h) in the second cross. Significance of these components indicated that, both additive and dominance gene effects are important in the inheritance of these characters. Hence, selection of the desired characters may be practiced in the early generations but may be more effective in latest one, Shehab El-Din (1993).

Dominance x dominance (e) type of gene action was significantly positive for 100 kernel weight in the two crosses and number of spikes/plant in the first cross. At the same time, number of spikes/plant and grain yield per plant showed significant negative (e) component for cross Π. On the other hand, positive significant additive x additive type of spistasis (i) was detected in both of two studied crosses for, number of kernels/spike and in the second cross for number of spikes/plant, and grain yield/plant. Also, significant negative (i) values were detected for number of spikes/plant in the first cross and 100-kernel weight in the second one.
Table (4): Heritability and expected versus actual gain for all studied characters in two crosses of bread wheat.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Cross</th>
<th>Heritability</th>
<th>Expected gain</th>
<th>Actual gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>breast</td>
<td>narrow sense</td>
<td>parent off</td>
</tr>
<tr>
<td>Number of spikes/plant</td>
<td>I</td>
<td>76.79</td>
<td>17.39</td>
<td>46.37</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>83.81</td>
<td>59.25</td>
<td>72.26</td>
</tr>
<tr>
<td>Number of kernels/spike</td>
<td>I</td>
<td>90.21</td>
<td>20.71</td>
<td>55.34</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>92.71</td>
<td>62.23</td>
<td>77.94</td>
</tr>
<tr>
<td>100 kernel weight</td>
<td>I</td>
<td>85.51</td>
<td>81.71</td>
<td>83.61</td>
</tr>
<tr>
<td>(g)</td>
<td>II</td>
<td>85.77</td>
<td>80.75</td>
<td>83.47</td>
</tr>
<tr>
<td>grain yield/plant</td>
<td>I</td>
<td>93.63</td>
<td>76.86</td>
<td>86.10</td>
</tr>
<tr>
<td>(g)</td>
<td>II</td>
<td>94.27</td>
<td>76.19</td>
<td>85.10</td>
</tr>
</tbody>
</table>
The important role of both additive and non-additive gene actions in certain studied characters indicated that, selection procedure based on the accumulation of additive effects may be very successful in improving these characters. Similar approaches were reported by Gouda et al. (1993), Al-Kaddoussi et al. (1994), El Hosary et al. (2000), Moustafa (2002) and Hendawy (2003).

Heritability in both broad and narrow senses between generations (parent off-spring regression) are presented in Table (4). High heritability values as a broad sense were detected for all the studied characters. High to moderate estimates of narrow sense heritability and parent-off-spring regression were found for all the studied characters in the two studied crosses. The difference in magnitude of both narrow sense and parent-off-spring regression heritability estimates for all the studied characters may be assure the existence of both, additive and non-additive gene effects in the inheritance of these characters. Similarly, Jatasra and Paroda (1980), Mosaad et al. (1990), Moshref (1996), El Sayed (2004), Abdel-Nour Nadia et al. (2005) reported these conclusions. Also, expected genetic gain and actual gain for all studied characters are shown in Table (4).

The expected genetic advance (Δg % of F2) and actual genetic advance (Δg % of F3) ranged from moderate to high values for all the studied characters except for, 100-kernel weight in the two studied crosses. These results indicated the possibility of practicing selection in early generations to be assure that these characters and hence, selecting high yielding genotypes. Dixit et al. (1970) recorded that, high heritability was not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain.

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تقدير التباين الر식ي للمحصول ومكوناته في هجينين من قمح الخيز

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أجريت هذه الدراسة في محطة البحوث الزراعية برمادة الهور لمدة أربعة مواسم من موسم 1982/1983 إلى موسم 1985/1986 على هجينين من قمح الخيز وهو (سما 92 x دوتف 2) و (جزر184 x جميزة 4) وقد أجريت الدراسة على كل من الأبوين والأجيال الأول والثاني والثالث. وقد أظهرت الدراسة صفاء عند النباتات على قرب وعدد حبوب سلالة المقدمة رائحة وزن حبوب النباتات الفردية.

ويمكن القول إن الدراسة كالتالي:

- أظهرت الدراسة أن مستويات إنجذاب الجيل الثاني كان معنوية في جميع الصفات تحت الدراسة في كل من مجموعتين الجيلين.

- كانت نتائج الدراسة حاصلة وقيمة عادية معينة في صفيحة وزن البذور وكذلك محصول حبوب النبات الفردي في كل الجيلين تحت الدراسة وكانت في حالة حبوب السميلة في الجيلين الأول.

- وضعنا الدراسة على مرتفع أفقية تبة الأبوين الأعلى في جميع الصفات تحت الدراسة في كل الجيلين حيث كنا نستفيد جزءًا كبيرًا من التفاوت الأعلى.

- وكذلك كانت نتيجة تجاوب الأب الأعلى أيضًا في صفيحة حبوب السميلة في الجيلين الثاني.

- كانت نتائج الدراسة داخلية معنوية ومعنوية في الجيلين الأول في صفيحة عدد النباتات على النباتات الفردية.

- عدد حبوب السميلة ومحصول حبوب النباتات الفردية كما أظهرت صفات وزن البذور حيث نقص الاضافة في الجيلين الثاني فقط.

- لوحظت الدراسة كذلك أن تأثير الفعل المضيف كان معنوي وموجبا في الجيلين الثاني في صفيحة عدد النباتات على النباتات وكل الجيلين تحت الدراسة.

- كانت نتائج الدراسة في سلالة معدلة لحبوين موجبة ومعنوية في مختلف الصفات تحت الدراسة في كل الجيلين.

- أظهرت الدراسة الكفاءة الزراعية بعلاوة الوضع فيما عامة معنوية ومعنوية في جميع الصفات تحت الدراسة في كل من الجيلين.

- أظهرت الدراسة أن الصفاء في جميع الصفات تحت الدراسة ما عدا صفاء عدد النباتات على النباتات وكل الجيلين تحت الدراسة.

- أظهرت دراسة تأثير الفعل السادي والمضيف أن هذا النوع من الفعل دوارًا ما في وراثة صفة وزن البذور عند نباتات الطيف السادي x سداي دوارًا ما وكذلك في براثة صفة عدد حبوب السميلة.

- كانت نتائج الدراسة عالية ملائمة مع تلك النتائج السابقة بنسب صفات التحديق المتنوعة من الاملحصول ومكوناته ووظيفية وكذلك يمكن أن يكون الفعلى الفاعل في الامكانيات المازدة لتحقيق الامكانيات من الاملحصول ومكوناته.

- أظهرت الدراسة أن تأثير الفعل الجيني الحقيقي والغير معنوي دوارًا ما في وراثة جميع الصفات تحت الدراسة.

- توصي الدراسة بالاخذ في الاعتبار الاستفادة من هجينين الثاني (جزر184 x جميزة 4) عند عمل برنامج برودة لتحسين محصول القمح في مصر ويؤدي هذا الاتجاه وجد دراسات سابقة تؤدي وجدت تلبية وثيقة بين الأصناف الداخلية في هذا الجين.