COMBINING ABILITY ANALYSIS FOR GRAIN YIELD AND ITS ATTRIBUTES IN BREAD WHEAT UNDER STRESS AND NORMAL IRRIGATION CONDITIONS
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ABSTRACT

In order to produce new genotypes under stress condition, seven parents of bread wheat (Triticum aestivum, L.) namely; Sakha 94(P1), Giza 168(P2), Sakha 93(P3), Line 6(P4), Sahel 1(P5), Sids 12(P6) and Gemmeiza 10(P7) were crossed at 2010/2011 growing season in a half-diallel pattern at El-Gemmeiza Agric. Res. Station, ARC, Egypt. In 2011/2012 season, the 7 parents along with their 21 F1 crosses were sown in two adjacent experiments under stress and normal irrigation at Bahteem Agric. Station, ARC. Randomized complete blocks design with four replications was used for each experiment.

Results showed that mean squares of genotypes, parents and crosses were highly significant for all studied traits under normal and stress irrigation. The mean squares associated with general and specific combining abilities were found to be highly significant for all traits at both irrigation levels as well as the combining analysis with a few except lines. This indicates that both additive and non-additive gene effects were involved in the inheritance of these traits. The estimates of GCA/SCA were more than unity suggesting the predominance of additive gene effects in determining the performance of plant height, days to heading, days to maturity, No. of spikes/plant, spike length and 100-grain weight. On the other hand, (GCA/SCA) ratio was less than unity for No. of grains/spike and grain yield/plant at stress condition and combining. The interaction between SCA x Irrigation recorded a significant effect for all traits except No. of days to heading, 100-grain weight and grain yield/plant. The ratios of GCA x I x GCA was much smaller than ratios of SCA x I / SCA for the same studied characters indicating that non additive effects were much more influenced by environmental changes than GCA. The crosses (P1xP2), (P1xP5); (P3xP4), (P5xP7); (P4xP6) and (P6xP7) recorded highest mean values for plant height, number of days to heading and maturity. However, the crosses (P1xP3), (P1xP7), (P3xP6) and the cultivars Sakha 94, Giza 168 and Sids 12 were superior grain yield/plant in their genotypes could be used for improving grain yield and other studied traits under normal and stress irrigation.

INTRODUCTION

Wheat is one of the most important cereal crop in Egypt. Total cultivated area of wheat in the season of 2011/2012 was about 3.1 million feddan, with an average yield of 18.2 (ardab/fed).\textsuperscript{*} Increasing wheat production per unit area could be possible rather than increasing the area devoted for wheat production due to limitations of arable land and irrigation water. The main goal of the Egyptian National wheat program is to develop high yielding wheat cultivars. This can be achieved through, genetic studies of stability and genetic components for wheat genotypes to select proper

\textsuperscript{*} (Statistical years book (1) comment, 2012).
lines from good genotypes. Plant height and spike characters are important plant attributes that determine the desirability of progeny of any cross. The appropriate selection of these traits may greatly contribute towards enhancement wheat yielding ability. Thus, informations on combining ability for yield attributes traits would be useful in development of better cultivars.

Successful breeding programs need continuous informations on the genetic variation and systems governing grain yield and its components. Contradictory results were obtained by many authors with respect to genetic systems governing yield and its components. Khalifa et al. (1984) and Hendawy (1990) indicated that both additive and non-additive gene effects played an equal role in the inheritance of grain yield, number of spikes/plant, number of kernels/spike and 100-kernal weight. While, El-Hennawy (1992), Darwish (1992) and Abd El-Mageed (1995) found that additive and dominance gene effects were significant for grain yield/plant, number of kernels/spike and 100-kernal weight. On the other hand, Mahmoud (1999) found that additive and non-additive gene effects were of great importance in controlling the genetic systems of grain yield and its components. The additive gene effect mainly influenced the inheritance of studied characters. Also, El-Sayed et al. (2000), Hamada and Tawfeleis (2001) El-Sayed (2004), Abdel-Nour, Nadya et al (2009), Moussa (2010) and El-Awady, Wafa (2011) showed that additive and non-additive gene effects were more important in controlling the genetic system for plant height, number of spikes/plant, number of kernels/spike, 100-kernel weight and grain yield/plant.

The present study was performed to estimate general and specific ability under stress and normal irrigation conditions for grain yield and its components in seven parental diallel crosses of bread wheat (Triticum aestivum L.).

**MATERIALS AND METHODS**

The present study was carried out at the experimental farm of El-Gemmeiza and Bahteem Agricultural Research Stations, Egypt during the two successive season of 2011/2012. Seven local wheat cultivars and line namely Sakha 94 (P1), Giza 168 (P2), Sakha 93 (P3), and one promising line 6(P4), Sahel 1(P5), Sids 12(P6) and Gemmeiza 10(P7) of bread wheat (Triticum aestivum, L.) were chosen to establish this study. Names and pedigree of the seven parental materials are present in Table (1).

In 2010/2011 season all possible crosses among the seven selected parents (without reciprocals) were made Gemmaiza Agricultural Research Station, to produce hybrid seeds of the 21 crosses. In the second season of 2011/2012, the 28 entries (21 F1’s and 7 parents) of each of the crosses were sown in two adjacent experiments at Bahteem Agricultural Research Station, El-Qalubia Governorate. The first experiment (stress experiment) was irrigated once (70 days after sowing irrigation). The second experiment (non-stress or normal experiment) was irrigated four times after planting irrigation. A boarder of fifteen meters was set between the two experiments. Each experiment was arranged in a randomized complete blocks design with
four replications according to Steel and Torri (1980). Each entry was planted in plot of three rows; 4.2 m long and 30 cm apart. Every row contained 22 seeds spacing 20 cm. Data were recorded on a random sample of 10 guarded plants for parents and F1 hybrids. Eight characters were studied, i.e. plant height (cm), days to heading and maturity, number of spikes/plant, spike length (cm), number of grains/spike, 100-grain weight and grain yield/plant (gm). The amounts of total rainfall during the second growing season are shown in Table (2).

Table 1. Names and pedigrees of the seven parents used in this investigation.

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Pedigree</th>
<th>Origin</th>
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<tbody>
<tr>
<td>P1</td>
<td>Sakha 94</td>
<td>OPATA/RAYON//KAUZ. CMBW90Y3180-0TOPM-3Y-010M-010M-010Y-010M-015Y-0Y-AP-0S.</td>
<td>Egypt</td>
</tr>
<tr>
<td>P2</td>
<td>Giza 168</td>
<td>MRL/BUC//SERI. CM93046-8M-0Y-0M-2Y-0B-0GZ.</td>
<td>Egypt</td>
</tr>
<tr>
<td>P3</td>
<td>Sakha93</td>
<td>Sakha92/TR 810328/S 8871-2S-2S-2S-0S.</td>
<td>Egypt</td>
</tr>
<tr>
<td>P4</td>
<td>Line 6</td>
<td>WEEBILL1*2/KIRITATI CGSS01B0063T-099Y-099M-099Y-099M-3WGY-0B.</td>
<td>Mexico</td>
</tr>
<tr>
<td>P5</td>
<td>Sahel 1</td>
<td>N.S.732/PIMA/VEE<em>S</em> CR73S-4SD-4SD-4SD.</td>
<td>Egypt</td>
</tr>
<tr>
<td>P6</td>
<td>Sids12</td>
<td>BUC//7C/ALD/5/MAYA74/ON//1160-147/3/BB/GLL/4/CHAT'S*/5/MAYA/VUL//CMH74A. 63014*4SX.SD7096-4SD-1SD-1SD-0SD.</td>
<td>Egypt</td>
</tr>
<tr>
<td>P7</td>
<td>Gemmeiza10</td>
<td>MAYA74<em>S</em>/0N//1160-147/3/BB/GLL/4/CHAT'S*/5/CROW'S* CGM5820-3GM-1GM-2GM-0GM.</td>
<td>Egypt</td>
</tr>
</tbody>
</table>

Table 2. Monthly total rainfall at Bahcheem Agricultural Research Station in 2011/2012 winter season.

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<tr>
<td>Rainfall mm/month</td>
<td>-</td>
<td>0.3</td>
<td>2.6</td>
<td>0.4</td>
<td>6.2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table contents were estimates over 150 mm

*Agro meteorological data climatic factor from Giza Station, (A.R.C).

The analysis of variance for combining ability effects was done following the technique of Griffing (1956). Diallel cross analysis designated as method 2 model 1 for each experiment. The combined analyses of the two experiments were carried out when homogeneity of error variance was detected (Gomez and Gomez, 1984).
RESULTS AND DISCUSSION

Mean squares for plant height, No. of days heading and maturity, No. of spikes/plant, spike length, No. of grain/spike, 100-grain weight and grain yield/plant under normal and stress environments as well as combined analysis are presented in Table 3.

The results showed that analysis of variance a significantly differed among the two irrigation treatments, with mean values being higher at normal irrigation than those at stress condition for all traits. It is clear that number of days from sowing to heading or maturity was increased significantly with increasing number of irrigation up to 4 irrigations. The reduction responds to drought for all traits caused by closing plants stomats, which reduces leaf transpiration and prevents the development of excessive water deficits in their tissues. The drawback of the stomatal closure for plants is that their carbon gain is lowered and their growth is impaired. These results are in agreement with that obtained by Hamada and Tawfeleis (2001); El-Sayed (2004) and Abdel-Nour, Nadya et al (2009).

Mean square for genotypes, parent, crosses and parent vs crosses were found to be significant for all the studied traits at both and across irrigation treatments except parent vs crosses for 100-grain weight at normal irrigation and grain yield/plant at stress condition indicating the presence of considerable amount of genetic variability valid for further genetical studies.

Genotype x irrigation, parent x irrigation, F1 x irrigation and parent vs crosses x irrigation mean squares were found to be significant for plant height, days to heading, days to maturity and number of grains/spike except parents x irrigation interaction for plant height and number of grains/spike. Mean squares of genotype x irrigation treatment, parents x irrigation, crosses x irrigation and parents vs crosses vs irrigation was insignificant for number of spikes/plant and 100-kernel weight suggesting that the parental materials were not affected by irrigation treatments. Similar findings was reported by El-Sayed (2004) and Hamada and Tawfeleis (2001).

The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were found to be highly significant for all traits in both irrigation levels as well as the combined analysis with a few exceptions Table (3). This indicate that both additive and non-additive gene effects were involved in the inheritance of these traits. The estimates of mean squares due to GCA were much higher in magnitude than these of (GCA/SCA ratio > 1) showing the preponderance of additive genetic variance in governing these traits, consequently, phenotypic selection procedure would be very successful in improving the studied traits. On the other hand, the ratio was less than unity for No. of grains/spike and grain yield/plant at stress condition and the combined analysis. These results were in the same line with that obtained by Abdel-Nour, Nadya et al (2009); Moussa (2010) and El-Awady, Wafaa (2011).
The mean squares of interaction between irrigation treatments and both types of combining ability were significant for all traits except SCA x irrigation for days to heading, 100-grain weight and grain yield / plant. For the exceptional traits additive effects were much more influenced by environmental conditions. Also, the ratios for GCA x irrigation /GCA were much higher than SCA x irrigation /SCA for days to heading, No. of spikes /plant and No. of grains /spike indicating that additive effects were more influenced by environmental conditions. For the remaining traits, the ratios of GCA x irrigation/GCA was much smaller than ratios of SCA x Irrigation /SCA. Such results indicate that non additive effects were much more influenced by environmental changes. These results are in agreement with the findings of Mahmoud (1999); El-Sayed (2004); Moussa (2010) and El-Awady, Wafaa (2011).

The mean performances of the seven parental wheat genotypes and their 21 F1 crosses are presented in Table (4). The parental wheat cultivar Sakha 94 (P1) and the F1 crosses which involved Sakha 94 were the tallest wheat genotypes. On the other hand, the parental wheat cultivar Sahel 1 (P5) and the crosses (P2xP5), (P3xP5), and (P4xP5) were the shortest ones among the evaluated wheat genotypes, indicating that the genes controlling the dwarf stature have been transmitted from the parental Sahel 1 to progeny. The wheat parental cultivar Gemmeiza 10(P7) was the latest, whereas the genotypes line 6(P4), Sahel 1(P5) and Sids 12 (P6) were the earliest ones. The good level of earliness pronounced in the performance of the crosses (P4xP6), (P5xP7), and (P1xP5) under the two irrigation levels and the combined. In continuous The wheat cultivar Sids 12(P6) produced the greatest number of No. of spikes /plant whereas, Sahel 1(P5) produced the lowest spikes number. The four cross combinations (P1xP3), (P2xP4), (P3xP4) and (P3xP5) gave the highest number of spikes/plant suggesting that these genotypes could be used for isolating new recombinants characterized by greater number of spikes/plant. As shown in Table(4), the parental wheat cultivar Sids 12 (P6) and the cross combinations (P1xP2), (P3xP7) and (P4xP7) gave the highest number of grains/spike whereas, the cross (P1xP7) gave the lowest number of grains/spike at both irrigation levels. Number grains/spike showed on increase under normal irrigation owing to the ultimate role of water irrigation in increasing number of fertile florets and hence number of spikelets /spike. For 100-grain weight, the mean performance of the crosses (P1xP2), (P1xP4), (P3xP7) and (P4xP7) were the heaviest under both irrigation treatments. The best crosses for grain yield/plant at stress conditions were (P1xP7), (P2xP7), (P3xP6) and (P4xP6) in addition to parental genotype Sahel 1. The mean performance of the parental genotype Gemmeiza 10(P7) and the crosses (P1xP6), (P1xP7), (P2xP4), (P2xP3) and (P3xP6) gave the highest mean values of grain yield/plant at normal irrigation condition whereas, the two crosses (P2xP6) and (P4xP7) were inferior for grain yield productivity. Grain yield /plant tended to increase under normal irrigation; such increase may be due to the important role of water in stimulating assimilation activities of wheat plats and hence increasing grain yield. Our results are in agreement with those reported by Abd El-Mageed (1995); El-Sayed (2004) and Abdel-Nour, Nadya et al (2009).
General combining ability effects "gi" of each parent for all studied characters at both irrigation levels as well as combined analysis are presented in Table (5). Such estimates being used to compare average performance of each parent with other genotypes to facilitate selection of parents for further improvement to drought resistance. High positive values would be of interest for all measurements in question except No. of days to heading and maturity where, high negative effects would be useful from the breeder point of view.

The parental cultivar "Sakha 94" P₁ exhibited significant positive "gi" effects for plant height and 100-grain weight at both irrigation treatments. Also, P₁ was the best combiner for spike length / plant at normal irrigation as well as the combined analysis. The cultivar Sakha 94 exhibited negative and highly significant GCA effects for days to heading and maturity, revealing that this cultivar could be considered as excellent combiner for developing early heading genotypes. The parental "Giza 168" P₅ showed a significant positive "gi" effects for spike length at both and across irrigation treatments, plant height and grain yield / plant at normal irrigation as well as combined analysis, and No. of grains /spike at stress condition. The parental cultivar "Sakha 93" P₃ expressed significant positive "gi" effects for plant height and No. of spikes / plant at normal irrigation as well as the combined analysis. However, it gave undesirable or insignificant "gi" effects for other traits. The parental Line P₄ seemed to be the best general combiner for earliness at both and across irrigation treatments. Also, it expressed significant positive "gi" effects for No. of grains /spike at stress as well as the combined analysis and No. of spikes /plant at normal condition .The parental variety "Sahel 1" P₅ seemed to be a good combiner for No. of grains /spike at normal condition and No. of days to heading at stress environment. The parental cultivar "Sids 12" P₆ expressed significant negative "gi" effects for days to heading. Meanwhile, it gave a significant positive "gi" effect for No. of spikes /plant under stress treatment as well as combined analysis. Also, it gave desirable GCA effect for No. of grains /spike at normal irrigation as well as the combined analysis and grain yield at normal condition and 100-grain weight at both environments. Our results are in agreement with those reported by Hamada and Tawfeleis (2001) and El-Sayed (2004).

Specific combining ability effects "Sij" of parental combinations were computed for all the studied characters under normal, stress irrigation treatments and combined analysis (Table 6).The greatest inter-and intra-allelic interaction as deduced from SCA effects were observed in crosses: (P₁xP₂), (P₁xP₃), (P₂xP₆), (P₅xP₇) and (P₆xP₇) for plant height, (P₁xP₂), (P₁xP₅), (P₃xP₄), (P₄xP₇), (P₃xP₆) and (P₅xP₆) for No. of days to heading, (P₁xP₂), (P₃xP₄), (P₃xP₇), (P₄xP₆) and (P₆xP₇) for No. of days to maturity; (P₁xP₂) and (P₃xP₇) for No. of grains /spike; (P₃xP₇) for 100-grain weight; (P₁xP₃) and (P₁xP₇) for grain yield /plant under low irrigation treatment and the three cross combinations (P₁xP₆), (P₁xP₇), (P₂xP₄), (P₃xP₆) under normal irrigation. These crosses might be of interest in wheat breeding programs as most of them involved at least one good combiner for the traits in view. Also, these crosses might be of interest to obtain new varieties or produced pure lines. These results are in agreement with those reported by Hamada and Tawfeleis (2001) and El-Sayed (2004).
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T 6
In general, most of the significant resulted from all crosses were higher magnitude under normal and stress irrigation, but results indicate that plants from (P1xP2), (P1xP5); (P3xP4), (P5xP7); and (P4xP6), (P6xP7) gave the highest mean values for plant height, days to heading and maturity. However, the crosses (P1xP3), (P1xP7), (P3xP6) and cultivars Sakha 94, Giza 168 and Sids 12 were the best to produce high yield under both irrigation treatments. Consequently, it could be also concluded that (P1xP3), (P1xP7) and (P3xP6) crosses could be of interest in a breeding program for genetic improvement of bread wheat under drought conditions.

REFERENCES


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تحليل القدرة العامة على التألف لمصوح الحيوب و مكوناتة في قمح الخبز تحت
الرى العادي والاجهاد المالي
محمد عبد الكريم خالد و صبيح محمد عبد الدائم
قسم بحوث القمح - مهق بحوث المحاصيل- مركز البحوث الزراعية- جيزة مصر

أجري هذا البحث دراسة استكشافية شاملة ودورية فريدة مع أبنية الأصولية بالنسبة لتصاقطات طول الديب وعدد الأبيات في طور السنابل وصوانتها ومشكلة تأثير القدرة العادية والقدرة على التألف وطبيعة العقل الجيني تحت روى العادية واجهاد الديب المالي. تم إجراء جميع التجايدات الديبية دون تغيير في المسمى الزراعي 2003/2004 في محلة بحوث الجيزة مركز البحوث الزراعية بين سن تركيب وراثية من مجموعة الخباز والوراثية، والتي أُثبتت على سنة أصاف تاجرة هي سخانة (9) و (الب)، و (P1xP2) و (P1xP5) و (P1xP7) بسلاسة سنة 1953 (4)، وبvenge (1). ويتم الحصول على ببوب الجيل الأول في محلة بحوث الجيزة ثم تتم تقييمه في الجيل الأول وبمجرد نظام مركز البحوث الزراعية تحت مستويين من البكاء العامي (عربع ربيعية تاسعة) و (الاجهاد المالي) (عربع ربيعية تاسعة) في فترة التحلي، في 160 يوم، في استماع قطاعات كاملة العضوية في أربع مكرات، ثم أجرى التحليل الأساسي على قراءات الإضاءة وتنبأ
القيل الأول للعثور على العوامل الزراعية التي تتحكم هذه الصفات.

ظهرت النتائج أن هناك معيونية عالية لكل من الاجهاد الزراعية والإضاءة والحجان لتصاقطات طول الديب
وعدد الأبيات في طور السنابل وصوانة وعدد السنابل للدباد ازول السنابل ووزن السنة حبة ووزن مصور الديب،
ووزن مصور الديب،

أظهرت القدرة العامة على التألف إلى وجود مئوية موجبة بالنسبة لتصاقطات طول الديب وعدد السنابل للدباد وهندسة السنابل ووزن السنة حبة ووزن مصور الديب، بينما أظهرت مصافات طول الديب وعدد الأبيات في طور السنابل وعند ميولية سالبة تحت مستويي الري،

أوضح النتائج أن الصفيج 188 أظهرت معينة سالبة لعدم طور السنابل والضج وعالية صفيحة 0.68开封
موجبة لطول الديب ووزن السنة حبة ووزن الديب،

الصفيج 188 188 188 188
وجبة لطول الديب ووزن السنة حبة ووزن الديب،

ووزن الديب تحت الرى العادي وطول السنابل ووزن السنة حبة تحت الاجهاد المالي،

أظهرت النتائج أن الصفيج 188 188 188 188
فمحة القدرة العامة على التألف إلى وجود معينة موجبة وسائبة للعثور الزراعية للجيزة،

أظهرت القدرة العامة على التألف وعند ميولية سالبة وسائبة للعثور الزراعية للجيزة،

تحت مستويي الري،

وأظهرت النتائج بعض النجاح التي تمت عبر جمعة خاصية وصولاً إلى أكثر من 70 ن،

وفي (P6xP4) (P1xP5) و (P1xP7) قدرة العامة على التألف تحت مستويي الري و (P1xP2) و (P1xP7) وإثبات طول السنابل وعند إربوب طور السنابل والضج، وكذلك الجين (P6xP7) (P7xP5) و (P4xP3) و (P6xP3) (P7xP1) (P3xP1)

اللبان،

وصفت هذه الدراسة أنه يمكن الاستقاءة من هذا التألف الزراعية للجيزة في النجاح بتصاقط الديب
وتصاقطات الأخرى الموردة في برامج تربية الشح تحت نظام الرى العادي والإضاءة المالي.

قام بتحكيم البحث
أ.د / طارق عبد السميع شريف
أ.د / أيوب عبد الخالق عزيز

كلية الزراعة- جامعة المنصورة
مركز البحوث الزراعية

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