HETEROSIS AND COMBINING ABILITY ANALYSIS OF SOME BREAD WHEAT CROSSES

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Abstract

A half diallel F1 cross among five bread wheat genotypes, namely Sids 7, Sakha 69, Gemmiza 9, Giza 168 and Sids 1 was evaluated for yield and its components. Heterotic effects were mainly attributed to over dominance effects. Average potence ratios revealed over dominance for the decreased number of spikes/plant, increased number of kernels/spike and higher grain yield. Absent dominance of kernel weight resulted from existence both negative and positive dominance. The results detected significant general and specific combining ability (GCA and SCA, respectively) for all studied characters. GCA/SCA ratios indicated the importance of additive gene action in the expression of all characters, except for kernel weight. The parents, Gemmiza 9, Giza 168 and Sids1 are good combiners for number of spikes/plant and grain yield. Meanwhile, significant SCA effects were found for the crosses (Sakha 69 x Giza 168), (Sakha 69 x Sids 1), (Gemmiza 9 x Giza 168), (Giza 168 x Sids 1) for grain yield and at least one of the yield components, with considerable heterotic effects.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is the world' s most important and widely grown cereal crop. Its importance derives from the many properties and uses of its grains, which makes it a staple food for more than one third of the world's population (Poehlman, 1987). During the last decades, the Egyptian National Wheat Research Program has developed more than 25 bread and durum wheat cultivars, with their proper cultural package, which caused a large green revolution increasing the total wheat production as much as 400% compared with its production in early 1980's (Wafaa El Awady, 2001).

The success of breeding program depends upon the presence of sufficient genetic variability among genotypes to permit effective selection. Estimation of type of gene action is very useful for choosing the most efficient breeding scheme. One of these methods is the diallel cross analysis (Griffing, 1956). However, Uddin and Joarder (1987), and Ikram and Tanach (1991) indicated that both additive and non-additive gene action play equal roles in the inheritance of grain yield, number of spikes/plant and number of kernels/ spike. Also, El – Hennawy (1992) proved that additive and dominance gene effects were important for grain yield and number of kernels/spike. Furthermore, results obtained by Mohammed (1999) from eight wheat genotypes revealed that additive and non-additive gene effects control the genetic system of grain yield and its components. In addition, El Sayed *et al.* (2000) and Mostafa (2002) found that both additive and dominance variances were significant for number of spikes/plant, number of kernels /spike, kernel weight and grain yield /plant. Similarly, Hamada and Tawfeleis, (2001) showed that additive and non–additive gene effects have important roles in controlling the genetic system for plant height, number of kernels/spike, kernel weight and grain yield/plant.

Heterosis can be recognized as the superiority in performance of hybrid individuals compared with parents (Feher, 1987). Better – parent heterosis is a comparison of the cross performance with that of the best of its parent.

The present investigation was designed to study the inheritance of grain yield and its components and to identify the best parents and crosses useful for breeding for high-yielding ability.

MATERALS AND METHODS

The field work of this investigation was conducted at EL Giza Agricultural Research Station, during the two successive seasons 2003/2004 and 2004/2005. Five bread wheat cultivars representing a wide range of genetic variability were selected for this investigation (Table 1).

Table 1. Names and Pedigrees of Five Parents of Bread Wheat.

No.	Variety	Name and Pedigree
1	Sids 7	Maya "S" /Mon "S" / cuh 74 A592 /3 / Sakha8*25D1002.
2	Sakha 69	Inia / RL 4220//7C/ Yr CM 15430 – 2s - 5s – 0s
3	Gemmiza 9	Ald"S"/ Huac"s"//Cmh74 A. 30/Sx GM 483-5 GM-1GM-0GM.
4	Giza 168	MRL/ BUC//Seri. CMH74A.630/SX//SER182/AGEWT CGM4611-2GM-3GM-1GM-0GM.
5	Sids 1	HD21/PAVON"S"//1158.57/MAYA74"S".

In 2002/2003 season, all possible crosses were made among the five parents. In the second season, The 15 crosses (excluding reciprocals) were planted in a field experiment using the randomized complete block design (RCBD) with three replications. The plot area was two rows, 30 cm wide, three meter long with single seeds sown 10 cm a part. Recommended cultural practices were followed. The studied characters were number of spikes/plant, number of kernels/spike, 100-Kernel weight(KWT)in grams, grain yield/plant (gm.), and total plant dry weight (gm.). Data were recorded on a random sample of 10 guarded plants from each row.

Data were subjected to regular analysis of variance according to Steel and Torri (1980). For general and specific combining ability, estimates were obtained by employing Griffing's (1956) diallel cross analysis, method 2, model 1 (fixed model). Better parent (BP) heterosis was estimated as the percentage deviation of the F1 mean from the mean of the better parent. Degree of dominance, expressed as potence ratio, was estimated according to Smith (1952).

RESULTS AND DISCUSSION

Mean performance.

Mean performance of the five parental genotypes and their F1 hybrids, for all studied characters, is presented in Table(2). ANOVA showed significant differences among genotypes for grain yield and each of its attributes.

Among the parental genotypes, Gemmiza 9 had the highest values for number of spikes/plant (20.03) and heaviest grain yield/ plant (33.23 gm.), while the cultivar Sids 7 gave the highest values for number of kernels/spike (92.16), and 100 kernel weight (4.54gm)

F1' s data indicated that the cross combination 3x5 produced the greatest number of spikes / plant (21.42), whereas, the cross 1x2 gave the lowest value (4.35) of spikes). For number of krnels, cross 1x2 followed by 1x5 showed the highest values (98.22 and 76.80), while the cross 4x5 produced the lowest number of kernels/ spike (41.3o). Crosses 3x5 and 4x5 produced the heaviest kernels (4.34 and 4.46 gms), while the cross 1x3 produced the lightest ores (3.21gms). Concerning grain yield/plant, crosses 2x4 and 3x5 yielded the highest (42.37 and 40.60 gms/plant, respectively), While, the cross 1x3 gave the least (16.53 gms/ plant).

Table 2. Mean Performance Of Five Bread Wheat Cultivars And Their F1's Crosses

Genotypes	Number of spikes/plant	Number of kernels/spike	100- kernel weight(gm)	Grain yield/ plant (gm)
Parents				
Sids7 P1	5.71	92.16	4.54	22.83
Sakha 69 P2	19.20	56.47	3.82	26.43
Gemmiza9 P3	20.03	55.87	3.99	33.23
Giza168 P4	18.84	67.73	4.14	29.93
Sids1 P5	15.97	65.63	3.92	31.20
F1crosses				
1x2	4.35	98.27	3.74	20.83
1x3	5.51	75.30	3.21	16.53
1x4	5.30	70.67	3 58	23.86
1x5	10.05	76.80	4.01	24.53
2x3	12.90	68.90	3.77	35.53
2x4	16.46	55.83	4.34	42.37
2x5	11.56	62.23	4.12	39.43
3x4	18.50	42.76	3.77	38.40
3x5	21.42	61.20	4.34	40.60
4x5	15.43	41.30	4.46	35.26
L.S.D at 0.05%	4.07	4.28	0.217	2.24

Potence ratios and degree of dominance

Potence ratios (Table 3) showed over dominance for decreased spikes/plant for all crosses, except for the cross 3x5 which showed over dominance for increased number of spikes/plant. Thus, there is only one cross, 3x5 to be used successfully to increase number of spikes/plant.

For number of kernels/spike, average potence ratios was 6.94 indicating highly positive over dominance for increased number of kernels. However, this result was due to the high estimates of only three crosses, i.e. 1x2 (6.11), 2x3 (42.43) and 4x5 (24.17) as well as five positively partial dominance. So, it is only the first three mentioned crosses that are promising to select number of kernels

100- kernel weight showed different potence ratios. Only one cross showed negative partial dominance against six crosses of negative over dominance. The three remaining crosses, namely cross2x4, 2x5, and 3x5 showed positive over dominance.

Grain yield averaged positive over dominance of 3.27. However, four crosses showed negative ratios (two as negative partial dominance and two with negative over dominance). Meanwhile,the remaining six crosses showed positively over dominance ranging from 2.3 to 8.22.

Table 3. Poteince Ratio Of The Fifteen Crosses For The Four Traits

Crosses	Dominance degree			
	Number of spikes/plant	Number of kernels/spike	100 - kernel weight	Grainyield/ Plant
1x2	-1.28	6.11	-1.20	-2.1
1x3	-1.03	0.07	-3.72	-2.21
1x4	-1.06	0.76	-3.75	-0.71
1x5	-0.15	-0.16	-0.72	-0.59
2x3	-16.0	42.43	-1.49	2.30
2x4	-7.00	-1.11	2.25	8.12
2x5	-3.72	0.28	5.06	8.22
3x4	-1.57	-3.21	-3.90	4.13
3x5	1.68	0.09	10.35	8.22
4x5	-1.38	24.17	-3.40	7.33
average	-3.15	6.94	-0.05	3.27

Heterotic effects

Better parent heterosis % for all recorded characters are given in Table (4). Only the cross 3x5 exhibited positive heterotic effects for number of spikes/plant as resulted from positive over dominance for increased spikes /plant. With regard to number of kernels/spike, only the two crosses 1x2 and 2x3 gave positive heterotic effects. For 100-kernel weight, the five crosses 1x2, 2x4, 2x5, 3x5 and 4x5 possessed positive hertrotic effects ranged from 4.31 and 17.5. For grain yield/plant, six crosses i.e. 1x2, 2x4, 2x5, 3x5 and 4x5 showed 6.92 – 41.56% heterosis over the best parents. These results suggest that these heterotic effects are caused by over dominance as indicated by the potence ratios (Table 3).

These results are in harmony with those obtained by Abd El- Ghani (1980) and Hassanien *et al.,*(1974)

Table 4. Heterosis Percentage Over Better Parent For Some Characters In Wheat Hybrids.

Genotype	Number of spikes/plant	Number of kernels/spike	100- kernels weight	Grain yield/plant
	B.P	B.P	B.P	B.P
1x2	-77.34	6.63	17.5	-21.19
1x3	-72.49	-18.29	-29.09	-50.26
1x4	-71.87	-23.32	-21.06	-28.98
1x5	-35.5	-16.67	-11.55	-15.70
2x3	-17.82	22.02	-6.09	6.92
2x4	-14.27	-7.57	4.76	41.56
2x5	-39.79	-5.18	5.18	26.38
3x4	-7.64	-36.87	-5.41	15.56
3x5	6.94	-6.75	4.31	21.88
4x5	-18.79	-39.02	7.73	13.01
L.S. D at. 0. 05	4.07	4.28	0.217	2.24

Combining ability

I- Analysis of variance

Highly significant of mean squares due to both general and specific combining ability for the parental genotypes and F1's were found (Table5). Mean square due to GCA were higher than those of SCA, except for 100- kernel weight. The high GCA/SCA ratios revealed that most genes controlling number of spikes/plant, number kernels/spike and grain yield/plant were of additive type indicating successful improvement by practicing pedigree methods selection. The results are in harmony with those of Abd El-Wahed (2001).

Table 5. Mean Squares From Combining Ability Analysis In The F_1 Wheat Crosses .

Source	d.f.	Mean			
		Number of spikes/plant	Number of kernels/spike	100-Kernel weight	Grain yield/plant
G.C.A	4	98.90**	571.66***	2.53*	127.49**
S. C.A.	10	14.14*	116.35*	4.82**	37.20*
Error	28	2.04	2.48	0.125	1.29
G.C.A/S.C.A. Ratio		6.99	4.91	0.52	3.43

II- General Combining Ability Effects.

Table (6) presents the estimates of GCA effects and their standard errors for the five parental genotypes. Results revealed that Gemmiza 9 showed significant, positive effect for number of spikes/plant and moderate effect for grain yield /plant indicating that Gemmiza 9 good combiner for both characters. The cultivar Sids 7 was found to be good combiner for number of kernels/spike. The cultivars Giza 168 and Sids 1 had desirable potential for number of spikes/plant, kernel weight and grain yield /plant. The crosses involving these good general combiners should produce promising segregation with higher mean performance of yield and its component. The present findings are in partially agreement with those obtained by Abd El- Majeed *et al.*, (2004) and El Sayed (2004) .

Table 6. Estimates Of General Combining Ability Effects Of Diallel Cross Parents.

Parents	General Combining Ability			
	Number of spikes/plant	Number of kernels/spike	100-kernel weight	Grain yield/plant
Sids7 P1	-6.265	15.565	-0550	-7.561
Sakha 69 P2	0.460	0.250	-0.183	0.953
Gemmizà9 P3	2.561	-5.230	-1.369	1.868
Giza168 P4	1.835	-4.561	0.598	2.201
Sids1 P5	1.410	- 6.021	1.503	2.539
SE gi	0.482	0.507	0.257	0.265
SE.gi-gi	0.582	0.802	0.406	0.419

III- Specific Combining Ability Effects

Specific combining ability effects for the studied characters of the ten F1 crosses are given in Tables (7). Two crosses (1x5 and 3x5) exhibited significant positive specific effects for number of spikes/plant. For number of kernel/spike, the five crosses (1x2), (1x5), (2x3), (2x5) and (3X4) had highly significant positive estimates. For kernel weight, crosses (2x4), (2x5), (3x5) and (4x5) possessed positive highly significant specific effects. The five crosses (2x3), (2x4), (2x5), (3x4) and 3x5 exhibited high potential of specific effects to improve grain yield if proper improving methods would be applied to use specific program that benefit from non – additive genes. These crosses showed also significant positive heterosis (Table 4) which were mostly attributed to over dominance (Table 3). These consistent results ensure that these crosses could be useful for improving grain yield, especially those utilizing the high yielding parents, Gemmiza.9, Giza 168 and Sids 1.

Table 7. Estimates of specific combining ability effects(Sij)of 10 wheat crosses.

Crosses	Number of spikse/plant	Number of kernels/ spike	100-kernel weight	Grain yield/plant
1x2	-3.261***	16.383***	-1.870***	-3.286**
1x3	- 4.153***	-1.103	-6.017	-8.500***
1x4	- 3.693**	-6.403**	-4.217	-1.500
1x5	1.482*	1.187	-0.889	-1.171
2x3	-3.544***	7.811**	-0.984	1.986
2x4	0.749	- 5.922**	2.916**	8.486***
2x5	-3.726***	1.935	2.878**	5.214**
3x4	0.691	4.93**	-1.498	3.605**
3x5	4.030***	- 12.151***	3.230***	5.367***
4x5	-1.234	-14.184***	2.463**	-0.200
S.E sij	1.340	1.310	0.664	0.685
S.E sij- sik	2.011	1.965	0.406	1.026
S.E. sij- ski	1.83	1.793	0.909	1.793

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قوة الهجين والقدرة على الائتلاف لبعض هجن قمح الخبز

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أجرى هذا البحث لتقييم الهجن الدائرية لخمسة تراكيب وراثية من قمح الخبز بمحطة البحوث الزراعية بالجيزة ٢٠٠٢/٢٠٠٣ و٢٠٠٣/٢٠٠٤ لتقدير قوة الهجين ودرجة السيادة والقدرة العامة والقدرةالخاصة على الائتلاف لصفة المحصول ومكوناته فى الجيل الأول ويمكن تلخيص النتائج كما يلى:

أظهرت التراكيب الوراثية المختلفة فروقا معنوية فى متوسطات الصفات المدروسة حيث أعطى الصنف جميزة ٩ أعلى قيم لمتوسطات عدد السنابل / نبات ومحصول الحبوب نبات الواحد بينما أعطى الصنف سدس٧ أعلى القيم لمتوسطات عدد الحبوب / سنبلة ووزن المائة حبة للنبات الواحد

أظهرت الدراسة وجود سيادة فائقة لنقص عدد السنابل/ نبات وزيادة عدد الحبوب/سنبلة ومحصول الحبوب/نبات بينما أرجع انعدام السيادة لصفة وزن ١٠٠حبة الى وجود سيادة لمختلف الاتجاهات (بالزيادة أحيانا وبالنقص أحيانا اخرى) وبناء علية تعزى قوة الهجين فى الصفات الى وجود السيادة الفائقة.

بالنسبة للقدرة العامة على الائتلاف أظهرت النتائج أن الصنف جميزة ٩ ذو قدرة عالية على الائتلاف لصفة عدد السنابل فى النبات ومحصول الحبوب بينما أعطى الصنف سدس٧ قدرة عالية على الائتلاف لصفة عدد الحبوب/سنبلة. وأعطى الصنف سدس١ قدرة عالية على الائتلاف لصفة محصول الحبوب فى الجيل الأول.

اظهرت تاثيرات القدرة الخاصة على الائتلاف انها تماثلت مع تلك المتحصل عليها من قوة الهجين.