J. Agric. Sci. Mansoura Univ., 31 (3): 1213 - 1220, 2006

HETEROSIS AND COMBINING ABILITY IN SOME BREAD WHEAT CROSSES

Moshref;M. Kh.
National Wheat Research Program,Field Crop Research Institute. A.R.C., Giza, Egypt.

ABSTRACT

A partial diallel crosses mating design was made among six common wheat cultivars and lines during 2003/2004 and 2004/2005 at El-Giza Agric. Res. Station, ARC. Significant mean squares were obtained for genotypes in all the studied characters, parents except No. of spikes/plant, 100-kernel weight and grain yield/plant, crosses except No. of spikes/plant No. of kernels/spike and grain yield/plant and parents vs. crosses except No. of spikes/plant and No. of kernels/spike. The mean squares associated with GCA and SCA were significant for most studied traits which indicated the presence of both additive and dominance types of gene effects. The ratio of GCA/SCA were more than unity in all traits except grain yield/plant indicated that additive and additive x additive gene effect was more important than dominance gene effect in the expression of these traits. The crosses P_2xP_4, P_1xP_4 gave significant values for heterosis relative to better parents for grain yield/plant recording 84.51% and 64.41%, respectively.

INTRODUCTION

Most studies on wheat revealed that general combining ability (GCA), was found to be more important than specific combining ability (SCA), for No. of spikes/plant, Al-Kaddoussi and Hassan (1991) and Eissa (1993). However, additive (GCA) and non-additive (SCA), genes effects were observed for grain yield/plant, No. of kernels/spike, 100-kernel weight and No. of tillers/plant, Saadalla and Hamada (1994). On the other hand El-Beially and El-Sayed (2002) concluded that mean square associated with GCA and SCA were significant for heading date, maturity date, plant height, No. of spikes/plant, No. of kernels/spike, 100-kernel weight and grain yield/plant. In addition Mostafa (2002), El-Sayed (2004) and El-Sayed and Moshref (2005) found that GCA and SCA were significant for yield, yield components and plant height. For GCA/SCA ratio, Hendawy (1994), Shehab El-Din and Abd El-Latif (1996), El-Bieally and El-Sayed (2002), Hamada (2002) and Abd El-Majeed et al (2004) reported that the ratioes of GCA/SCA were more than unity in yield and yield components indicated that additive gene effects were more important than dominance in the expression of these characters. Several authors detected significant heterosis in most crosses of wheat for yield and its components as reported by Walia et al (1993), El-Hosory et al (2000), Hamada (2002) and El-Sayed and Moshref (2005).

The objective of this research was to study the types of gene action controlling in some of the economic characters in some of bread wheat crosses.

MATERIALS AND METHODS

The present study was carried out at El-Giza Agricultural Research Center (A.R.C). Giza Reseacrh Station, Wheat research department during two successive growing seasons, 2003/2004 and 2004/2005. Six common bread wheat cultivars and lines (Triticum aestivum L.) were used as parents' lines for diallel cross analysis. The name and pedigree of these cultivars or lines are presented in Table (1).

In 2003/2004 growing season, all possible combinations were made among the six parents without reciprocal to produce 15 hybrids grains , F_1. in 2004/2005 growing season. The six parents and the obtained 15 F_1 hybrids (21 genotypes), were grown for evaluation in a randomized complete blocks design (RCBD) with four replications according to Steel and Torri (1980). Each e ıtry was planted in three rows 3m long, 30-cm. abart and the distance betwe‹‹n plants within row was 10 cm. The recommended agricultural practices were applied from sowing to harvest. Data for the studied traits were recorded on twenty competitive plants were randomly chosen from the parental genotypes and F_1's hybrids.

The studied characters were heading date (H.D), maturity date (M.D), plant height (P.H), No. of spikelets/spike (Spt/S.), No. of spikes/plant (S./P.), No. of kernels/spike (K./S.), 100-kernels weight (100 K.Wt.) and grain yield /plant (G.Y./P.). The obtained data were analysed to estimate general combining ability (GCA) and specific combining ability (SCA) according to method II model I of Griffing (1956). Heterosis effect was computed as the percentage deviation of F_1 mean performance for either mid and better parent values according to Wynne et al (1970).

Table (1): The name and pedigree of parental cultivars and lines

o.	Parent	Pedigree	Origin
P_1	Giza 168	Mrl/Buc//Seri	Egypt
P_2	Sakha 93	Sakha 92/TR810238	Egypt
P_3	Gemmeiza 9	Ald"S"/ Huac"S"// Cmh74A.630/Sx.	Egypt
P_4	Gemmeiza 10	Maya 74"S"/0N//1160-147/3/BB/Gll/4/Cat "S"/5/Crow "S"	Egypt
P_5	Sids 1	HD2172/Pavon "S"//1158.57/Maya 74 "S"	Egypt
P_6	PBW343	ND/Vg9144//Kal/BB/3/Yaco/4/Vee #5	Mexico

RESULTS AND DISCUSSION

1) Analysis of Variance:

Data presented in Table (2) showed that mean squares were significant for all the studied characters among genotypes, parents except No. of spikes/plant, 100 kernel weight and grain yield/plant and for crosses except No. of spikes/plant, No. of kernels/spike and grain yield/plant revealing the presence of sufficient variability in the populaticn. Parents vs. crosses was significant for all studied characters except No. of spikes/plant and No. of kernels/spike indicating the heterosis of F_1 hybrids. The significance of general combining ability (GCA) for the studied characters except grain yield/plant and specific combining ability (SCA) for heading date, plant height, 100 kernel weight and grain yield/plant revealed the presence of both additive and dominance types of action were important in the inheritance of studied traits.

The ratio of GCA/SCA were more than unity in all studied characters except grain yield/plant which indicated that additive gene and additive x additive types of effects were more important than dominance in the expression of these traits. However, a lower ratio of GCA/SCA than unity was observed for grain yield/plant (0.85), indicating that dominance gene effect was responsible for the inheritance of grain yield/plant. These results are in line with those obtained by Al-Kadoussi and Hassan (1991), Saadalla and Hamada (1994), El-Beially and El-Sayed (2002), Abd El-Majeed et al (2004) and El-Sayed and Moshref (2005).

Table (2): Mean square analysis and combining ability analysis for studied characters of diallel crosses.

S.O.V	d.f.	H.D.	M.D.	P.H	Spt/S.	No. S/P.	No. K/S.	100K. wt.	G.Y/P.
Genotypes	20	149.34	13.97	143.13	3.27	83.62	145.58	0.43	1124.17
Parents	5	245.34	28.94	251.84	5.40	67.57	273.40	0.35	323.44
Crosses	14	122.42	8.24	107.19	2.38	86.48	105.58	0.44	846.85
Par. VS. Cro.	1	46.20	19.20	102.79	5.07	123.83	66.40	0.74	9010.31
G.C.A.	5	129.40	10.26	123.09	2.41	75.04	70.39	0.12	248.62
S.C.A.	15	6.65	1.23	6.68	0.22	2.86	25.05	0.10	291.86
Error	60	3.49	3.78	11.08	0.58	47.76	69.90	0.18	498.95
GCA/SCA		19.46	8.34	18.43	10.95	26.24	2.81	1.20	0.85

*** Significant at 5%**

2) Heterosis :

Significant differences of parents vs crosses mean squares were detected for all studied characters except No. of spikes/plant and No. of kernels/spike as shown in Table (2). Heterosis expressed as percentage deviation of F_1 performance from its mid and better parents average values for all studied traits are presented in Table (3). The results showed that the heterosis values were significantly different among hybrids for heading date, it ranged from 7.47 % for cross P_5xP_6 to 1.81 % for cross P_2xP_3 as mid parents from –6.57 % for cross P_5xP_6 to 12.93 % for cross P_2xP_3 as better parents and for maturity date ranged from –0.08% for cross P_1xP_2 and P_2xP_5 to 1.82% for cross P_2xP_3 as mid parents and from 0.50% to 2.84 % for crosses P_2xP_3 and P_2xP_4. For plant height heterosis values ranged from –2.40 % for cross P_4xP_6 to 6.90% for cross P_2xP_4 and from –10.30% for cross P_4xP_5 to 4.81% for cross P_2xP_4 as mid and better parent, respectively. For No. of spikelets/spike 12 and 5 crosses were positive and significant as mid and better parent, respectively.

Table (3): Percentage of heterosis over both mid and better parent values for the studied characters.

	H.D.		M.D.		P.H		Spt/S.		No.S/P.		No.K/S.		100K. wt.		G.Y/P.	
Genotypes	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
$P_1 \times P_2$	-3.91	-1.15	-0.08	0.50	1.60	-3.29	5.38	1.73	4.94	4.24	2.98	1.55	-8.45	-14.10	8.60	0.38
$P_1 \times P_3$	1.52	9.24	1.56	1.98	3.51	2.48	-0.21	-4.00	27.06	21.97	0.02	-1.06	4.15	-1.35	45.56	26.48
$P_1 \times P_4$	-4.23	1.63	0.65	1.49	5.96	-1.01	-0.09	-0.94	31.06	16.23	8.76	2.87	13.20	12.06	71.26	64.41
$P_1 \times P_5$	-6.99	-0.54	0.32	2.15	1.46	-2.34	2.03	-0.08	15.72	-2.51	6.07	-4.89	15.94	11.63	35.48	30.59
$P_1 \times P_6$	-1.42	4.35	1.08	1.50	0.92	-2.78	2.80	2.14	7.39	-0.57	21.41	13.04	14.88	6.93	29.30	25.70
$P_2 \times P_3$	1.81	12.93	1.82	2.84	0.79	-4.96	0.22	-6.80	-9.15	-13.34	-11.01	-11.30	9.90	8.81	25.58	17.40
$P_2 \times P_4$	-2.76	6.32	1.40	2.84	6.90	4.81	0.93	-3.36	43.08	26.15	9.37	4.84	7.58	0.00	91.97	84.51
$P_2 \times P_5$	-0.39	9.77	-0.08	2.34	3.57	-4.92	3.95	-1.66	12.41	-5.81	-1.98	-10.99	-2.71	-5.29	36.74	22.20
$P_2 \times P_6$	1.45	10.63	1.50	1.67	2.07	0.82	2.90	-1.28	2.69	-5.51	2.87	-5.46	11.57	10.61	12.43	1.26
$P_3 \times P_4$	0.36	1.69	0.57	0.98	3.75	-3.97	1.44	-1.60	-12.01	-19.00	9.61	4.75	4.91	-1.57	20.10	8.21
$P_3 \times P_5$	-2.50	-1.91	-0.40	0.98	1.45	-1.41	2.24	0.40	-10.25	-21.71	-6.02	-14.92	-1.71	-3.37	29.15	8.79
$P_3 \times P_6$	0.35	1.95	0.99	1.83	6.43	1.55	5.79	2.40	19.41	14.98	9.60	1.02	2.09	0.22	39.59	18.42
$P_4 \times P_5$	-0.48	0.24	0.96	1.95	-0.52	-10.30	2.10	0.83	-5.82	-11.22	-13.77	-18.53	8.29	3.26	27.82	18.47
$P_4 \times P_6$	-0.24	0.00	0.74	2.00	-2.40	-5.46	2.35	2.13	30.14	24.18	13.78	0.62	-4.69	-12.12	40.37	31.16
$P_5 \times P_6$	-7.47	-6.57	-0.57	1.66	3.15	-4.22	3.16	1.66	1.86	-8.10	-0.58	-16.29	-1.35	-4.76	22.82	21.75
S.D 5%	4.57	5.28	2.38	2.75	4.08	4.71	0.93	1.07	8.46	9.77	10.23	11.82	0.51	0.59	27.36	31.59

* Significant at 5%

The hybrid vigor in No. of spikes/plant ranged from –12.01% for cross P_3xP_4 to 43.08 % for cross P_2xP_4 as mid parents and from –21.71 % for cross P_3xP_5 to 26.15 % for cross P_2xP_4 as better parent. On the other hand for No. of kernels/spike varied from -13.77% and 18.53% for cross P_4xP_5 to 21.41 % and 13.04% for cross P_1xP_6 for mid and better parents, respectively. For heterosis values for 100 kernel weight vigor varied from –8.45% for cross P_1xP_2 to 15.94% for cross P_1xP_5 as mid parents and from –14.10 % for cross P_1xP_2 to 12.06% for cross P_1xP_4 as better parents. Meanwhile for grain yield/plant 10 crosses were positive and significant as mid parent and ranged from 8.60% for cross P_1xP_2 to 91.97 % for cross P_2xP_4 and two crosses P_1xP_4 and P_2xP_4 only were positive and significant as better parent with values 64.41% and 84.51%, respectively. These results are confirmed with those obtained by El-Beially and El-Sayed (2002), Mostafa (2002) and El-Sayed and Moshref (2005).

3) General combining ability (GCA):

The GCA effect for the studied characters are presented in Table (4). For heading date, Giza 168 (P_1) and Sakha 93 (P_2) and for maturity date sakha 93 (P_2) and PB343 (P_6) were negative and significant, so these parents expressed considered good combiner for earliness and decrease significant number of days to heading and maturity. With respect to plant height (P_1), and (P_5) had the significant positive GCA effect while (P_2), (P_4) and (P_6) were significant negative GCA effects, suggesting that these parents were good general combiner to decrease plant height. For No. of spikelets/spike Gemmeiza 9 (P_3) and Sids1 (P_5) were good combiner to increase No. of spikelets/spike. Gemmeiza 10 (P_4) and Sids 1 (P_5) were significant positive effects for No. of spikes/plant and No. of kernels/spike, suggesting that these parents had an additive gene effects and good combiners for increasing No. of spikes/plant and No. of kernels/spike. With respect to 100-kernel weight parent No. 6 (PBW343), had positive and significant GCA, so (P_6) had additive gene effects in the inheritance of 100-kernel weight. For grain yield/plant Giza 168 (P_1), and Gemmeiza 10 (P_4) and were significant positive for GCA in the inheritance of grain yield/plant, so these parents revealed good combiners for increasing grain yield/plant.

Table (4): General combining ability effects of parents for the studied characters.

No.	Parents	H.D.	M.D.	P.H	Spt/S.	No. S/P	No. K/S.	100K. w	G.Y/P.
1	Giza 168 (P_1)	-4.42	-0.51	1.73	-0.22	-0.86	0.28	-0.08	3.35
2	Sakha 93(P_2)	-5.54	-1.20	-2.93	-0.93	-1.94	-1.69	0.09	-4.07
3	Gemmeiza 9(P_3)	4.55	0.30	3.05	0.73	-2.20	-1.98	0.05	-9.41
4	Gemmeiza 10(P_4)	2.11	0.90	-4.83	-0.11	2.52	3.11	-0.18	4.99
5	Sids 1 (P_5)	1.49	1.61	5.26	0.39	2.55	3.84	-0.04	3.27
6	PBW343 (P_6)	1.80	-1.10	-2.27	0.14	0.43	-3.57	0.16	1.86
L.S.D5%	g_i	1.21	0.63	1.07	0.24	2.23	2.70	0.14	3.21
	$g_i - g_j$	1.87	0.97	1.66	0.38	3.46	4.18	0.21	11.17

* Significant at 5%

Generally, Giza 168 (P_1) and Sakha 93 (P_2) were good combiner for early heading and maturity, Gemmeiza 10 (P_4) good combiner for decreasing plant height and No. of spikelets/spike, Gemmeiza 10 (P_4) good combiner for No. of spikes/plant and No of kernels/spike, Sids 1 (P_5) good combiner for increasing plant height, No. of spikelets/spike, No. of spikes/plant and No. of kernels/spike and Parent PBW343 was good combiner for early mature, decreasing plant height and increasing 100-kernel weight . Also, Giza 168 (P_1), Gemmeiza 10 (P_4) and Sids (P_5) were good combiner for grain yield.

4) Specific Combining Ability (SCA):

The results in Table (5) showed that two crosses P_1xP_5 and P_5xP_6 as well as P_1xP_2 and P_5xP_6 were significant negative for days to heading and maturity, respectively. This indicated that these crosses mainted a desirable non-additive gene effect to selection for earliness in heading and maturity, respectively. Meanwile, for plant height P_1xP_4, P_2xP_4 and P_3xP_6 were significant positive SCA and P_1xP_2 and P_3xP_6 were significant positive for No. of spikelets/spike, these results revealed that they had a considered non-allelic gene effects in these combinations for plant height and No. of spikelets/spike.

Table (5): Specific combining ability of crosses for the studied characters.

Cross		H.D.	M.D.	P.H	Spt/S.	No. S/P.	No. K/S.	100K. wt.	G.Y/P.
$P_1 x P_2$		-2.16	-1.09*	-0.51	0.83*	-1.90	-0.28	-0.56*	-11.34
$P_1 x P_3$		2.25	1.41*	1.27	-0.33	4.70*	-2.06	-0.02	11.87*
$P_1 x P_4$		-2.32	0.07	3.65*	-0.21	3.94*	1.70	0.28	23.41*
$P_1 x P_5$		-3.69*	0.35	0.06	0.09	2.13	3.78	0.47*	8.95
$P_1 x P_6$		0.50	0.18	-0.66	0.16	-1.48	6.92*	0.42*	5.14
$P_2 x P_3$		1.12	1.60*	-1.58	-0.32	-2.81	-6.23*	0.35	0.91
$P_2 x P_4$		2.19	1.00	4.09*	-0.07	7.90*	5.04*	0.18	34.49*
$P_2 x P_5$		1.43	-0.46	1.96	0.42	2.14	0.97	-0.20	10.18
$P_2 x P_6$		1.87	1.25*	0.24	0.07	-1.69	-0.91	0.41*	-5.16
$P_3 x P_4$		0.21	-0.25	1.33	0.16	-4.92	5.27*	0.06	-8.19
$P_3 x P_5$		-1.41	-0.96	-0.26	0.16	-2.80	-1.81	-0.16	5.63
$P_3 x P_6$		0.28	0.50	4.33*	0.90*	3.95*	3.11	0.03	12.63*
$P_4 x P_5$		1.78	1.19*	-1.88*	0.20	-4.09*	-9.73*	0.21	-1.63
$P_4 x P_6$		0.71	0.16	-3.61*	0.14	4.95*	3.98	-0.36	7.46
$P_5 x P_6$		-5.41*	-1.06*	2.05	0.14	-0.99	-1.30	-0.17	3.92
S.D5%	S_{ij}	3.31	1.02	2.95	0.67	3.13	4.41	0.37	11.80
	$S_{ij} - S_{ik}$	4.94	2.57	4.40	1.00	9.14	11.06	0.55	29.55
	$S_{ij} - S_{kl}$	4.57	2.38	4.08	0.93	8.46	10.24	0.51	27.36

*** Significant at 5%**

Meanwhile, P_1xP_3, P_1xP_4, P_2xP_4, P_3xP_6 and P_4xP_6 showed significant positive SCA effects for No. of spikes/plant indicating that they had a considerable non-allelic gene effects in inheritance of this trait. For No. of kernels/spike three crosses , P_1xP_6, P_2xP_4 and P_3xP_4 have significant positive SCA effects, so their segregating lines may have high number of kernels/spike. The crosses , P_1xP_5, P_1xP_6 and P_2xP_6 were significant positive SCA effects in 100-kernel weight, these results indicating that these crosses contained an epistatic effect in the inheritance of this trait. For grain yield/plant the crosses P_1xP_3, P_1xP_4, P_2xP_4 and P_3xP_6 have significant positive SCA effects, these results suggested that these crosses had non-allelic gene action for increasing grain yield/plant and could be used in the segregating generations to produce lines that have high grain yield/plant. Similar results were obtained by Al-Kaddoussi and Hassan (1991), Saadalla and Hamada (1994), El-Beially and El-Sayed (2002), Mostafa (2002), Hamada (2002), Abd El-Majeed et al (2004) and El-Sayed and Moshref (2005).

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قوة الهجين والقدرة على الائتلاف لبعض هجن قمح الخبز

محمد خلف مشرف

البرنامج القومي لبحوث القمح – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر .

أجري هذا البحث بهدف تقييم الهجن الناتجة من التهجين النصف دائري لستة أصناف من قمح الخبز هي (جيزة ١٦٨ ، سخا ٩٣ – جميزة ٩ ، جميزة ١٠ ، سدس ١ و السلالة PBW 343) وذلك في مزرعة محطة التجارب الزراعية بالجيزة خلال الموسمين الزراعيين ٢٠٠٣/٢٠٠٤ حيث أجري التهجين بين الأباء المختلفة وفي موسم ٢٠٠٤/٢٠٠٥ تم تقييم الهجن الناتجة وعددها ١٥ هجين بالإضافة إلى الاباء الستة .

كان التباين الراجع للتراكيب الوراثية معنويا في صفات الدراسة كلها وتباين الآباء كان معنويا في صفات عدد الأيام حتى طرد السنابل وعدد الأيام حتى النضج وطول النبات وعدد السنيبلات بالسنبلة وعدد الحبوب بالسنبلة . وتباين الهجن كان معنويا في صفات عدد الأيام حتى طرد السنابل وعدد الأيام حتى النضج وطول النبات وعدد السنيبلات بالسنبلة ووزن المائة حبة ، بينما كان التباين الراجع للتفاعل بين الآباء والهجن معنويا في صفات عدد الأيام حتى طرد السنابل وعدد الأيام حتى النضج وطول النبات وعدد السنيبلات بالسنبلة ووزن المائة حبة ومحصول النبات من الحبوب . وقد أظهرت نتائج تحليل التباين معنوية القدرة العامة على الائتلاف لكل من صفات عدد الأيام حتى طرد السنابل وعدد الأيام حتى النضج وطول النبات وعدد السنيبلات بالسنبلة وعدد السنابل بالنبات وعدد حبوب السنبلة ووزن المائة حبة . وأظهرت القدرة الخاصة على الائتلاف معنوية لكل من عدد الأيام حتى طرد السنابل وطول النبات ووزن المائة حبة ومحصول الحبوب للنبات ، مما يوضح أثر فعل الجين الإضافي وتفاعلاته (مضيف × مضيف) والسائد على صفات الدراسة ، وعلى الرغم من ذلك كانت النسبة GCA/SCA أعلى من الوحدة الصحيحة لكل صفات الدراسة ما عدا صفة محصول الحبوب للنبات ، مما يوضح أهمية فعل الجين الإضافي عن الفعل السائد للجين في صفات الدراسة وأوضحت قوة الهجين أن الهجينين P_1xP_4, P_2xP_4 هما أعلى الهجن قيمة في قوة الهجين بالنسبة لصفة محصول الحبوب في للنبات عن متوسط الأبوين أو أعلى من أحسن الأبوين .