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HETEROSIS AND COMBINING ABILITY FOR SOME BREAD WHEAT CROSSES

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ABSTRACT

A partial diallel crosses matting design was made among seven common wheat varieties and lines during 2000/2001 and 2001/2002 seasons at the Farm of the Fac. of Agric. Al-Azhar univ. Madient Nasr, Cairo, Egypt. Significant mean squares were obtained for genotypes, parents, crosses for all traits studied. Parents vs crosses for heading date, No., Kernels/spike 1000- Kernels weight and Grain yield/plant were also significant. P_1 and P_5 were at the top of the tested parents in grain yield/plant. The two crosses P_2 X P_5 and P_2 x p_6 gave the highest values of grain yield/plant. The mean squares associated with GCA and SCA were significant for all traits studied which indicated the presence of both additive and non-additive types of gene effects including dominance.The ratioes of GCA/SCA were more than unity in all traits except for No. spikes/plant which indicated that additive gene effects were more important than dominance in the expression of these traits. The crosses P_2 X P_5 , P_2 X P_6 , P_2 X P_7 and P_3 X P_6 gave significant values for heterotic effect relative to better parent for grain yield/plant.

INTRODUCTION

Information regarding the types of gene effects controlling different traits in wheat are of prime necessity before starting a breeding program. Joshi (1979) stated that genetic studies involving high yielding and widely adapted parents need more attention because their crosses are expected to offer desirable genetic variability.

Most studies on wheat revealed that general combining ability (GCA) was found to be more important than specific combining ability (SCA) for numbers of spikes/plant and grain yield; Busch *et al.* 1971, Raghavaiah and Joshi 1986, Dasgupta and Mondal 1988, Al-Kaddoussi and Hassan 1991, Eissa 1993. However, additive (GCA) and non-additive (SCA) gene effects were observed for grain yield, kernels/spike 1000-kernel weight and tillers numbers/plant ;Sharma *et al.* 1984; Srivastava *et al.* 1992, and Saadalla and Hamada 1994. The mid parent heterosis for grain yield varied from 5 to 58% while it varied from 17 to 41% for better parent heterosis (Cregan and Busch 1978), meanwhile khalil *et al.* (1979) and Bitzer *et al.* (1982) reported that heterosis over mid parent for grain yield was significant in crosses between high x high and high x low but it was insignificant for low x low parents. On the other hand, heterosis percentage based on better parent varied from 17 to 38, 9 to 18, zero to 7 , 9 to 45 and from 2 to 58% for grain yield, tillers number/plant, kernels number/spike, spike yield and 100-kernel weight, respectively.In a study by singh *et al.* (1991), they found that GCA was insignificant and SCA was significant for grain yield.

The objective of this study was to assess the types at gene action controlling some of the economic traits in some wheat crosses.

MATERIALS AND METHODS

The present study was carried out at the experimental farm of Faculty of Agric. Al-Azhar Univ. during 2000/2001 and 2001/2002 growing seasons. Seven common wheat varieties and lines (*Triticum aestivum L.*) representing a wide divergent germplasm were slected for this study from National Wheat Program (NWP), Field crops Res. Inst. (FCRI), Agric. Res. Cent. (ARC). The name, pedigree and code number of these varieties or lines are presented in Table 1. In 2000/2001 seasons, grains of each of the parental varieties were sown at 3 various dates to produce 21 F_1 hybrid grains. In 2001/2002 growing season the seven parents and the obtained 21 F_1 hybrids were grown for evaluation in a randomized complete blocks design (RCBD) with 3 replications. Each entry was planted in two rows 2m long, 30 cm abart and the distance between plants within row was 10 cm. The recommended agricultural practices were applied from sowing to harvest. Data for the following traits were recorded on 10 plants chosen at randon from each plot.

The studied traits were heading date (H.D), maturity date(M.D), plant height(PL.H), spike length(S.L), No. spike / plant(S/P), No. kernels / spike(K/S), 1000 kernel weight(Kwt) and grain yield/plant(G.Y/P).

The obtained data were analysed to estimate general and specific combining abilities according to method II model I of Griffing (1956). Heterosis was computed with respect to better and mid parents according to Bhatt (1971) formula.

Table 1: The name and pedigreeof parental varieties and/or line valuated

No.	Parent	Origin
P_1	Giza 164	Egypt
P_2	Mildeess Mo 73/pol// T. aest.-Bon/con-7c	Mexico
P_3	IREN.A	Mexico
P_4	Tsi/vee "s" // Giza 165	ICARDA
P_5	Sids 7	Egypt
P_6	Sakha 8	Egypt
P_7	Gemmeiza 7	Egypt

RESULTS AND DISCUSSION

1- Mean performance and analysis of variance:-

The mean performances of the seven parental lines and varieties of wheat are presented in table 2. The preliminary ANOVA revealed the presence of significant differences among genotypes for all studied traits. The parental lines P_5 and P_4 gave the lowest values for heading and maturity date, respectively. The parental lines or varieties P_7, P_4, P_6. P_3, P_5 and P_5 were at the top of the tested parents for spike length, plant height, No, spikes/plant, No Kernels/spike, 1000 kernel weight and grain yield/plant, respectively.

Table 2: Mean of characters studied for seven parents and their21 F_1 crosses

Genot.	H.D	M.D	Pl.H	S.L	No. S/P	No. K/S	1000 kwt	G. Y/P
P_1	86.0	141.7	88.2	11.7	13.0	50.5	44.07	26.05
P_2	99.0	139.3	103.6	10.5	13.4	40.6	45.50	24.09
P_3	95.3	137.3	88.4	12.0	14.4	51 1	33.68	22.31
P_4	85.3	139.0	108.8	12.3	9.4	35.1	55.78	19.81
P_5	81.0	139.7	84.0	10.5	10.0	32.9	74.46	27.57
P_6	87.7	146.0	85.3	10.6	18.4	46.4	34.35	24.70
P_7	87.3	144.7	90.3	12.0	12.8	31.1	37.79	22.54
P_1xP_2	96.0	143.3	91.6	13.1	10.4	64.6	44.29	30.75
P_1xP_3	94.0	135.7	95.8	12.2	11.2	56.5	44.39	28.44
P_1xP_4	92.0	134.3	88.9	12.2	10.2	42.8	42.80	20.39
P_1xP_5	85.7	136.0	89.5	10.3	10.2	48.7	52.52	24.86
P_1xP_6	90.7	145.3	87.3	10.9	14.6	40.9	41.69	25.15
P_1xP_7	94.0	138.3	83.0	11.6	12.2	47.2	41.69	22.42
P_2xP_3	94.3	136.3	91.1	13.0	10.4	51.5	44.02	27.25
P_2xP_4	91.3	136.0	106.8	12.8	12.0	28.1	49.54	29.52
P_2xP_5	81.7	133.3	103.1	12.5	15.8	51.5	45.96	42.05
P_2xP_6	89.0	139.7	97.3	12.6	14.2	32.7	49.10	39.07
P_2xP_7	93.3	137.7	88.2	11.9	15.6	52.5	43.43	33.95
P_3xP_4	94.0	138.3	97.5	12.1	12.2	44.0	39.62	19.63
P_3xP_5	94.7	138.3	99.2	10.3	9.6	57.5	41.17	23.98
P_3xP_6	96.7	145.0	88.4	12.5	19.4	47.9	36 07	35.64
P_3xP_7	95.0	144.7	92.5	11.3	16.2	39.2	34.85	24.74
P_4xP_5	97.0	146.7	99.7	12.3	6.2	51.3	49.27	15.84
P_4xP_6	92.3	146.3	103.3	11.4	7.6	56.5	44.65	18.73
P_4xP_7	92.7	146.3	104.1	12.5	9.8	59.2	41.89	27.71
P_5xP_6	96.0	146.7	93.7	11.8	10.8	56.3	42.94	29.43
P_5xP_7	95.7	146.3	94.4	11.5	15.2	60 3	37.64	38.29
P_6xP_7	92.7	144.0	83.7	11.5	13.0	55.9	38.92	30.47
L.S.D 5%	2.50	2.7	0.81	9.5	1.5	2.3	3.00	3.19

Data presented in Table 3 showed that crosses mean squares were significant for all the studied traits among genotypes, parents and crosses, revealing the presence of sufficient genetic variability in the population. The significance of general combining ability (GCA) and specific combining ability (SCA), indicated the presence of both additive and nonadditive types of gene effects in the genetic system controlling these traits this materials. The ratio of GCA/SCA Table 3, were more than unity in all traits except No. kernels/spike which indicated that additive gene effects were more important than non additive in the expression of these traits. However, a lower ratio of GCA/SCA than unity was observed for No. kernels/spike (0.35), indicating that nonadditive gene effects play an important role in the inheritance of No. kernels/spike. These results are in line with those obtained by Bhatt (1971), Singh *et al.* (1987), Eissa (1993), El-Sayed *et al.* (2000) and Mana (2001).

Table 3: Observed mean squares from ordinary analysis and combining ability analysis in the F_1 diallel

S. O. V.	d. f	H.D	M.D	Pl.H	S.L	No. S/P	No. K/S	1000 kwt	G. Y/P
Genotype	27	65.29*	56.74*	165.23*	3.51*	4.16*	280.18*	195.01*	18.13*
Parents	6	115.43*	30.41*	273.10*	4.15*	7.67*	210.13*	631.27*	11.17*
Crosses	20	41.02*	67.44*	138.18*	3.49*	3.32*	255.99*	64.10*	533.11*
P. VS. C.	1	250.00*	0.67	39.84	0.04	0.05	1184.30*	195.52*	85.90*
GCA	6	73.14*	122.97*	475.16*	10.70*	10.01*	114.47*	555.13*	25.39*
SCA	21	63.05*	37.97*	76.68*	1.45*	2.49*	327.52*	92.12*	16.05*
Error	54	2.34	2.70	33.66	0.24	0.09	8.18	3.38	0.43
GCA/SCA		1.16	3.24	6.20	7.38	4.02	0.35	6.02	1.58

General combining ability (GCA):-

The GCA effects for traits studied are presented in Table 4. Four parents were significant in GCA effects for heading date and P_5 and P_1 had the highest negative GCA (-2.413 and –1.116), respectively which were desirable for this trait and it was considered as a good combiner for earliness of heading. On the other hand P_1 (Giza 164), P_2 and P_3 were significant and negative for maturity date suggesting that these parents were considered good general combiner to decrease number of days to maturity. With respect to plant height P_1 (Giza 164) and P_6 (Sakha 8) had negative and significant GCA effects, while the parents P_2 and P_4 had the positive and significant GCA effects, suggesting that these parents were considered as a good general combiner to decrease or increase plant height. For spike length P_2 and P_5 (Sids 7) was a good combiner to increase spike length. For number of spikes/plant P_2 , P_3 , P_6 and P_7 were positive and significant GCA effects, suggesting that these parents were considered as a good combiners to increase number of spikes/plant. With respect of number of kernels/spike the three parent P_1 (Giza 164),P3(IREN.A) and P_5 (Sids 7) were positive and significant for GCA suggesting that they had an additive gene effects and were considered as a good combiners for increasing number of kernels/spike.

Table 4: Estimates of general combining ability effects of parents for the studied traits in the F_1 diallel

Parents	H.D.	M.D.	Pl.H	S.L	No. S/P	No. K/S	1000 kwt	G. Y/P
P_1	-1.116*	-1.243*	-4.259*	-0.224*	-0.099	2.315*	0.107	-0.222
P_2	1.032*	-2.503*	3.844*	0.869*	0.286*	-2.070*	1.815*	1.506*
P_3	2.772*	-1.614*	-1.052	-0.009	0.382*	2.004*	-4.837*	-0.226
P_4	-0.487	-0.169	7.452*	-0.131	-0.766*	-3.174*	3.148*	-1.432*
P_5	-2.413*	-0.095	-0.348	0.810*	-0.877*	1.182*	7.148*	-0.760*
P_6	-0.190	3.497*	-2.926*	-0.790*	0.701*	0.241	-3.219*	0.659*
P_7	0.402	2.127*	-2.711*	-0.524*	0.375*	-0.499	-4.504*	0.465*
L.S.D 5%								
gi	0.545	0.586	2.067	0.175	0.108	1.019	0.655	0.232
gi-gj	0.833	0.85	3.158	0.268	0.163	1.556	1.000	0.355
r for mean and GCA								

With respect to 1000-kernel weight P_2, P_4 and P_5, had positive and significant GCA effects (1.815, 3.148 and 7.148), respectively. Meanwhile P_3, P_7 and P_6 had negative and significant GCA effects with values of -4.837 , -3.219 and –4.504, respectively. These results indicated that each of P_2, P_4 and P_5 had additive gene effects in the inheritance of 1000-kernel weight. For grain yield/plant parents, P_2, P_6 and P_7 had positive and significant GCA effects and two parents P_4 and P_5 had negative and significant GCA effects for this trait. These results suggested that Sakha 8 and Gemmeiza 7 had additive gene action and were considered as a good combiner for increasing grain yield/plant. This may be due to the high linkage between yield and number spikes/plant.

Generally, the variety Giza 164 was a good combiner for early heading and maturiety, the line Mildeess Mo 73 / pol // T. aest-Bon / con-7c, (P_2)was good combiner for No. spikes/plant, 1000 kernel weight and grain yield/plant, IRENA (P_3)was a good combiner for No. spikes/plant, No. kernels /spike, P_4 was a good combiner for 1000 kernel weight, Sids 7 was a good combiner for No. kernels/spikes, and 1000 kernel weight, Sakha 8 was a good combiner for No. spikes/plant and grain yield/plant and Gemmeiza 7 was a good combiner for No. spikes/plant and grain yield/plant.

Specific combining ability (SCA):-

The results in Table 5 showed that four crosses P_1 x P_5, P_2 x P_3, P_2 x P_5 and P_2 x P_6 and 9 crosses P_1 x P_3, P_1 x P_4, P_1 x P_5, P_1 x P_7, P_2 x P_4, P_2 x P_5, P_2 x P_6, P_2 x P_7 and P_6 x P_7 were negative and significant for days to heading and maturity, respectively.This indicated that these crosses maintained a desirable non additive gene effect to selection for earlines in heading and maturity, respectively. Meanwhile for plant height P_1 x P_3 and P_3 x P_5 were positive and significant for SCA and P_1 x P_4 and P_2 x P_7 were negative and significant SCA.For spike lenght P_1 x P_5, P_2 x P_5, P_3 x P_6 and P_4 x P_7 were positive and significant for SCA. Meanwhile P_2 x P_4, P_2 x P_5, P_2 x P_7, P_3x P_4, P_3 x P_6, P_3 x P_7, and P_5 x P_7, showed positive and significant SCA effects for No. spikes/plant indicating that they had a considerable non-allelic gene effects in these combinations. For number of kernels/spike 12 crosses (P_1 x P_2, P_1 x P_3, P_2 x P_3, P_2 x P_5, P_2 x P_7, P_3 x P_5, P_4 x P_5, P_4 x P_6, P_4 x P_7, P_5 x P_6, P_5 x P_7, and P_6 x P_7), have positive and significant SCA effects, so segregating lines may have high number of kernels/spike. The crosses P_1 x P_3, P_2 x P_3, P_2 x P_6, P_2 x P_7, and P_6 x P_7 were positive and significant SCA effects in 1000 kernel weight, this results indicating that these crosses contained an epistatic effect in the inheritance of this trait. For grain yield/plant the crosses (P_1 x P_3, P_2 x P_4, P_2 x P_5, P_2 x P_6, P_3 x P_6, P_4 x P_7, P_5 x P_6, and P_5 x P_7) have positive and significant SCA effects, this results suggesting 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 yiels/plant. Similar results were obtained by Khalil *et al.* (1979), Bajwa *et al.* (1986), Eissa (1993), Attia (1998), El-Sayed *et al.* (2000) and Mana (2001).

Table 5: Estimates of specific combining ability for crosses studied in the F_1 diallel

crosses	H.D	M.D	Pl.H	S.L	No. S/P	No. K/S	1000 kwt	G. Y/P
P_1xP_2	4.287*	6.139*	-1.835	0.099	-0.781	16.751*	-1.507	0.212
P_1xP_3	0.546	-2.417*	7.261*	0.077	-0.611*	4.544*	5.245*	1.163*
P_1xP_4	1.806*	-5.194*	-8.176*	0.166	0.204	-3.945*	-4.329*	-0.305
P_1xP_5	-2.602*	-3.602*	0.224	0.692*	0.315	-2.368	1.049	0.514
P_1xP_6	0.176	2.139*	0.669	-0.442	0.204	-9.227*	0.922	-0.807*
P_1xP_7	2.917*	-3.491*	-3.880	-0.042	-0.270	-2.219	-1.340	-1.525*
P_2xP_3	-1.269*	-0.491	-5.509	-0.249	-1.263*	3.995*	3.166*	-0.963*
P_2xP_4	-1.009	-2.269*	1.654	-0.327	0 419*	-14.227*	0.705	1.011*
P_2xP_5	-8.750*	-5.009*	5.787	1.732*	1.796*	4.818*	-7.218*	4.516*
P_2xP_6	-3.639*	-2.269*	2.565	0.132	-0.315	-13.042*	6.613*	2.105*
P_2xP_7	-0.102	-2.898*	-6.783*	-0.868*	0.478*	7.432*	2.244*	0.592
P_3xP_4	-0.083	-0.824	-2.783	-0.116	0.389*	-2.434	-2.569*	-0.594
P_3xP_5	2.509*	-0.898	6.750*	0.477	-3.67*	6.744*	-5.355*	0.213
P_3xP_6	2.287*	2.176*	-1.472	0.944*	1.322*	-1.982	0.246	2.681*
P_3xP_7	0.028	3.213*	2.446	-0.523	0.581*	-9.908*	0.320	-0.756*
P_4xP_5	8.102*	5.991*	-1.220	-0.801*	-0.352*	5.721*	-5.247*	-1.282*
P_4xP_6	1.213*	2.065*	4.957	-0.068	-1.463*	11.862*	0.846	-1.739*
P_4xP_7	0.954*	3.435*	5.476	0.732*	-0.404*	15.269*	-0.626	1.450*
P_5xP_6	6.806*	2.324*	3.157	-0.608	-0.285	7.240*	-5.211*	1.158*
P_5xP_7	5.880*	3.361*	3.609	-1.208*	1.507*	11.981*	-9.220*	4.304*
P_6xP_7	5.657	-2.565*	-4.546	0.458	-0.804*	8.521*	2.927*	0.278
L.S.D 5%								
Sij	0.883	1.899	6.699	0.570	0.349	3.302	2.122	0.753
Sij-sik	2.355	2.532	8.932	0.759	0.465	4.402	2.829	1.004
Sij-skl	2.203	2.368	8.355	0.710	0.434	2.059	2.647	0.470
r for mean and GCA								

Heterosis:-

Differences in significance for parents vs. crosses mean squares were detected for heading date, No. kernels/spike, 1000 kernel weight and grain yield/plant as shown in Table 3. Heterosis expressed as percentage deviation of F_1 performance from its mid-parent and better parent average values for all studied traits are presented in Table 6.

For heading date three crosses expressed significant negative heterotic effect from the mid parents but for maturity date five crosses expressed significant negative heterotic effect over mid parent and only two over better parent. Significant negative heterotic effect for earlines was previously detected by El-Shamarka (1980), Karrar (1980), Darwish (1992). Hendawy (1994), El-Sayed (1996), El-Sayed *et al.* (2000) and Mana (2001).

For plant height four and two crosses exhibited significant positive heterotic effects relative to mid-parent and better parent, respectively. Significant positive heterotic effect relative to the taller parent was found by El-Shamarka (1980), Karrar (1980), El-Henawy (1996), Hendawy (1990), Darwish (1992), Ashoush (1996), El-Sayed *et al.* (2000) and Mana (2001).

Concerning spike length 14 crosses significantly exceeded mid-parent value. Also, nine hybrids had significant positive heterotic effects relative to better parent value.

Table 6: Percentage of heterosis over both mid and better parent values for all characters studied in the F_1 diallel

Genotypes	H D		M D		Pl.H		S.L		No. S/P		No. K/S		1000 kwt		G. Y/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	M.P	B.P
P1xP2	3.78*	11.62	1.99	1.72	-4.48	-11.58*	18.01*	11.97*	-21.21*	-22.39*	41.82*	27.92*	-1.11	-2.66	22.66*	18.04*
P1xP3	3.70*	9.30*	2.74*	-1.18	8.49*	3.37	2.95*	1.64*	-18.25*	-22.22*	11.22*	10.57*	14.19*	0.73	17.62*	9.17*
P1xP4	7.41*	7.85*	-4.31*	-3.38*	-9.75*	-18.29*	1.67*	-0.81*	-8.93*	-21.54*	0.00	-15.25*	-14.27*	-23.27*	-11.08*	-21.73*
P1xP5	2.64*	5.80*	-3.34*	-2.65	3.95	1.47	-7.21*	-11.97*	-11.30*	-21.54*	16.79*	-3.56*	-11.38*	-29.47*	-7.27*	-9.83*
P1xP6	4.43*	5.47*	1.01	2.54	0.63	-1.02	-2.24*	-6.84*	-7.01*	-20.65*	-15.58*	-19.01*	6.32*	-5.40*	-0.89	-3.45*
P1xP7	8.48*	9.30*	-3.42*	-2.40	-7.00	-8.08	-2.11*	-3.33*	-5.43*	-6.15*	15.69*	-8.53*	1.86*	-5.40*	-7.72*	-13.93*
P2xP3	-2.93*	-1.05	-1.45	-0.73	-5.10	-12.07*	11.56*	8.33*	-25.18*	-27.78*	12.32*	0.78	11.19*	-3.25*	17.46*	13.12*
P2xP4	-0.92	7.03*	-2.26	-2.16	0.56	-1.84	12.28*	4.07*	5.26*	-10.45*	-23.12*	-30.79*	-2.17	-11.19*	34.49*	22.54*
P2xP5	-9.22*	0.86	-4.44*	-4.31*	9.91*	-0.48	19.05*	19.05*	35.04*	17.91*	40.14*	26.85*	-23.37*	-38.28*	62.80*	52.52*
P2xP6	-4.66*	1.48	-2.07	0.29	3.02	-6.08	9.09*	18.87*	-10.69*	-22.83*	-24.83*	-29.53*	22.98*	7.91*	80.16*	58.18*
P2xP7	0.16	6.87*	-3.03*	-1.15	-9.03*	-14.86*	5.78*	-0.83*	19.08*	16.42*	46.44*	29.31*	4.29*	-4.55*	45.61*	40.93*
P3xP4	4.10*	10.20*	0.11	0.72	-1.12	-10.39	-0.41	-1.63*	2.52*	-15.28*	2.09	-13.89*	-11.42*	-28.97*	-6.79*	-12.01*
P3xP5	7.43*	16.91*	-0.14	0.73	15.08*	12.22*	-12.34*	-14.17*	-21.31*	-33.33*	36.90*	12.52*	-23.86*	-44.71*	-3.85*	-13.02*
P3xP6	5.68*	10.26*	2.36*	5.61*	1.78	0.00	9.17*	4.17*	18.29*	5.43*	-1.74	-6.26*	6.04*	5.01*	51.63*	44.29*
P3xP7	4.05*	8.82*	2.62*	5.39*	3.53	2.44	-5.8*	-5.8*	23.53*	12.5*	-4.62*	-23.29*	-2.48	-7.78*	10.32*	9.76*
P4xP5	16.66*	19.73*	5.27*	5.34*	3.42	-8.36	7.89*	0.00	-36.08*	-38.00*	50.88*	46.15*	-24.34*	-33.83*	-33.09*	-42.55*
P4xP6	6.71*	8.21*	2.67*	5.25*	6.13	5.06	-4.60*	-7.32*	-45.32*	-58.70*	38.65*	21.77*	-0.92	-19.95*	-15.84*	-24.17*
P4xP7	8.68*	8.67*	3.14*	5.25*	4.62	-4.32	2.88*	1.62*	-11.71*	-23.44*	78.85*	68.66*	-10.46*	-24.90*	30.86*	22.94*
P5xP6	13.81*	18.52*	2.7*	5.01*	10.81	9.85*	11.85*	11.32*	-23.94*	-41.30*	41.99*	21.34*	-21.07*	-42.33*	12.61*	6.75*
P5xP7	13.73*	18.15*	2.88*	4.72*	8.32*	4.54	3.42*	-4.17*	33.33*	18.75*	88.44*	83.28*	-32.94*	-49.45*	52.82*	38.88*
P6xP7	5.94*	6.19*	-0.93	0.48	-4.67	-7.31	1.77*	-4.17*	-16.67*	-29.35*	44.26*	20.47*	7.90*	2.99	29.00*	23.36
L.S.D.5%	2.16	2.50	2.33	2.68	8.20	9.47	0.70	0.81	0.42	0.49	4.04	4.67	2.60	3.00	0.92	1.07

Spike length in fact may be lead to erratic judgement as the long spike could be lax or dense and, therefor, number of spiklets and kernels per spike could be resulted in better criterion for spike density than spike length. These results are in agreement with findings of Karrar (1980), Mitkees (1981), Mosaad *et al.* (1990), Ashoush (1996), El-Sayed *et al.* (2000) and Mana (2001).

For the number of spikes/plant seven and five crosses exhibited significant positive heterotic effect relative to mid parent and better parent, respectively. In this respect positive heterosis for number of spikes/plant was obtained by Gyawali *et al.* (1968), Mani and Rao (1975), Ashoush (1996), El-Sayed *et al.* (2000) and Mana (2001).

For number of kernels/spike, 14 and 11 crosses significantly exceeded the mid parent and better parent values, respectively. Significant positive heterotic effect for number of kernels/spike was found by Darwish (1992), Ashoush (1996), El-Sayed *et al.* (2000) and Mana (2001).

For thousand kernel weight, 8 and 2 crosses showed positive and significant heterotic effect for mid parent and better parent respectively. Similar results were obtained by El-Sayed (1996), El-Sayed *et al.* (2000) and Mana (2001).

Concerning grain yield/plant 13 and 12 crosses showed significant positive heterotic effect relative to mid parent and better parent values, respectively This hybrids exhibited heterosis for one or more traits contributed yield. This finding agreed with the general trend where the expression of heterosis for a complex trait is always a function of its components. It could be concluded that these crosses would be efficient and prospective in wheat breading programs for improving grain yield/plant. Significant positive heterotic effects relative to the better yielding parent were also determinded by Sharma *et al.* (1986), Hendawy (1990), Darwish (1992), Mekhamer (1995), Ashoush (1996), El-Sayed (1996), El-Sayed *et al.* (2000) and Mana (2001).

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قوة الهجين والقدرة على الائتلاف لبعض هجن قمح الخبز

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أجرى تقيم الهجن الناتجة من التهجين النصف دائرى لسبعة أصناف وسلالات من قمح الخبز في مزرعة كلية الزراعة جامعة الأزهر وذلك في عامي ٢٠٠٠/٢٠٠١م حيث أجرى التهجين بين الآباء المختلفة وفي موسم ٢٠٠١- ٢٠٠٢ و تم تقييم الهجن الناتجة و عددها ٢١ هجين بالإضافة إلى الاباء السبعة.

كان التباين الراجع للأباء والهجن معنويا لكل صفات الدراسة وكان التباين الراجع للتفاعل المشترك بين الأباء والهجن معنويا في أربعة صفات فقط هي تاريخ التزهير وعدد حبوب السنبلة ووزن ١٠٠٠ حبه ومحصول الحبرب بالنبات.

كان الأب الأول والخامس هما الأعلى في محصول النبات من الحبوب والهجنين $P_2 \times P_5$, $P_2 \times P_6$ هما الأعلى أيضا في محصول الحبوب للنبات.

أظهرت نتائج تحليل التباين معنوية كل من القدرة العامة والخاصة على الائتلاف مما يوضح أثر فعل الجين الإضافي والسائد على صفات الدراسة وعلى الرغم من ذلك كانت النسبة GCA/SCA أعلى من الوحدة الصحيحة ما عدا صفة عدد حبوب السنبلة مما يوضح أهمية فعل الجين الإضافي عن الفعل السائد للجين في صفات الدراسة.

وأوضحت قوة الهجين أن الهجين $P_2 \times P_7$ $P_2 \times P_5$ $P_2 \times P_3$. $P_3 \times P_7$ هي أعلى الهجين قيمة قوة الهجين بالنسبة لصفة محصول الحبوب.