Minufiya J. Agric. Res. Vol. 32 No.4: 1087 - 1108 (2007)

HETEROSIS AND COMBINING ABILITY ANALYSIS OF SOME QUANTITATIVE CHARACTERS IN BREAD WHEAT (*Triticum aestivum* L.)

H. A. Dawwam, F. A. Hendawy and Mona M. Serage EL-Din
Field crops Dept. Fac. Of Agric., Minufiya Univ., Egypt

(Received: May , 30 , 2007)

***ABSTRACT** : Nine wheat cultivars were used in a diallel cross to study (i) The potentiality of heterosis expression for grain yield and some of its components, i.e. heading date, plant height, number of tillers per plant, number of productive tillers per plant, main culm spike length, number of spikelets per main culm spike, main culm spike weight, number of grains per main culm spike, grain weight per main culm spike, main culm spike density, spike length, grain weight per spike, grain yield per plant and 1000-grain weight and (ii) The magnitude of both general and specific combining ability in order to formulate the most efficient breeding procedures .The obtained results can be summarized as follows:*

- *Fifteen hybrid combinations significantly exceeded their respective higher parents for grain yield per plant and these useful heterosis was varied from 13.26% to 97.45% over the respective better parents. The most desirable heterosis was detected by the cross Sakha 206XGemmieza 7. Genotypes, parents and the resultant thirty six crosses mean squares were found to be highly significant for all traits studied except main culm spike density. Parent vs. crosses mean squares as an indication to average heterosis overall crosses were found to be highly significant for all traits studied except for number of productive tillers per plant, main culm spike weight and grain weight per plant. Both general and specific combining ability variances were found to be highly significant for all traits studied, indicating the importance of both additive and non-additive genetic variances in determining the performance of these traits. The GCA/SCA ratios revealed that additive and additive X additive types of gene action were of greater importance in the inheritance of all traits studied except number of both tillers and productive tillers and grain weight per plant where the non-additive genetic variance were of greater importance in the inheritance of these three traits. The parental cultivar Sids 7 proved to be good general combiner in grain yield and was also found to be good combiner for twelve* *traits i.e. heading date, number of both tillers and productive tillers, main culm spike length, spikelets per main culm spike, main culm spike weight, grains per main culm spike, grain weight per main culm spike, spike length, grain weight per spike, grain yield per plant and 1000-grain weight. The most desirable SCA effects for grain yield per plant were detected by the three crosses i.e. Giza 168 X Sids 1, Sids 1 X Gemmieza 7 and Gemmieza 3 X Gemmieza 7.*

Key words : *Heterosis, general and specific combining ability, diallel cross and wheat.*

INTRODUCTION

The right starting of the initiation of any breeding programme needs that the materials under investigation should be subjected to genetic analysis to find out the relative magnitude of various types of the genetic variances to formulate the most efficient breeding procedures to achieve quick and maximum improvement.

In recent years, combining ability analysis is the most widely used biometrical tool for classifying lines in terms of their ability to combine in hybrid combinations. With this method the resulting total genetic variation is partitioned into general combining ability, measure of additive gene action, and specific combining ability, measure of non-additive gene action.

Improvement of yield in wheat through conventional breeding methods has reached a level at which phenomenal increase seem to be rather difficult. This warrant to think of some new breeding approach which might increase the yield considerably. The development of hybrid wheat is one way of increasing wheat production. Heterosis has long been observed in wheat, but to be of potential value, a hybrid should be more profitable than the best available commercial wheat varieties. The basic tools for hybrid wheat production, such as cytoplasmic male sterility, the fertility- restoring system and cross- pollination under field conditions are available (Wilson, 1968).

The objectives of the present study are to establish (i) The potentiality of heterosis expression for grain yield and some of its components. (ii) The magnitude of both general and specific combining ability .

MATERIALS AND METHODS

The present experiment was carried out at the Experimental Farm, Faculty of Agriculture, Minufiya University at Shebin El-Kom during the two successive seasons 2003/2004 and 2004/2005. Nine common wheat varieties were used to establish the experimental materials for this investigation. A diallel cross set excluding reciprocals was carried out among the nine varieties in 2003/2004 growing season. The evaluation of the nine wheat varieties and their possible thirty six hybrid combinations were carried out in 2004/2005 growing season, using a randomized complete block design with three replications. The experimental units consisted of single rows 3 meters long with 20 cm. between rows, plants within rows were 10 cm. apart allowing a total of 30 plants per row. Normal agricultural wheat practices were applied as usual for the ordinary wheat fields in the area. Heading date was recorded on an individual plant basis. At maturity, twenty guarded plants were randomly chosen from each row for subsequent measurements as follows:

Heading date, plant height, number of tillers per plant, number of productive tillers per plant, main culm spike length, number of spikelets per main culm spike, main culm spike weight, number of grains per main culm spike, grain weight per main culm spike, main culm spike density, spike length, grain weight per spike, grain yield per plant and 1000-grain weight.

The data were first analysed to test the significance of the forty five different genotypes. If the genotypes mean squares are found to be significant, there is need to proceed for further analysis, i.e.Griffing's approach; method 2 model 1 (1956).

The average heterotic effects overall the studied crosses (parent vs. crosses) were calculated by partitioning the genotypes sum of squares to its components, i.e., parents, crosses and parent vs crosses. Useful heterosis for each trait of individual cross were expressed as percent increase of the F_1 performance above the better parent value.

A test of significance of these heterosis effects, L.S.D. values were calculated as suggested by Wynne *et al.* (1970).

RESULTS AND DISCUSSION

Useful heterosis expressed as the percentage deviation of F_1 mean performance from the better parent for all traits studied are presented in Table (1). High positive values of heterosis would be of interest in all characters studied except heading date and plant height, high negative values would be useful from the wheat breeder point of view . As for heading date, eleven out of the thirty six crosses studied were found to exhibit highly significant negative useful heterotic effect which ranged from – 0.991% to –

Table (1): Percentage of heterosis over better parents for all characters studied .

Genotypes	Heading date (days)	Plant height (cm)	Number of tillers / plant	Number of Productive tillers	Main culm spike length (cm)	No. of spikelets /main culm spike	Main culm spike weight (gm)	No. of grains / main culm spike	Grain weight / msin culm spike (gm)	Main culm spike density	Spike length (cm)	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Sakha93XSakha 206	8.099**	14.19**	49.59**	59.72**	-3.874**	-0.756**	32.91**	34.89**	26.29**	-8.893**	-7.496**	-0.688**	92.21**	-7.765**
XGiza 164	13.07**	12.85**	-22.44**	-23.17**	-10.61**	-5.000**	-6.720**	-10.80**	-1.585**	3.819**	-6.293**	12.65**	-11.63**	0.297
XGiza 168	5.516**	25.99**	-16.15**	-17.77**	-4.849**	1.167**	2.973**	6.792**	-8.486**	1.637**	-2.975**	9.923**	-10.94**	-13.97**
XGiza 170	8.920**	14.56**	-17.37**	-10.71**	-5.259**	1.955**	-18.71**	-6.124**	-28.19**	-1.255**	-6.877**	-35.63**	-41.37**	-24.60**
XSids 1	7.896**	27.52**	11.46**	-8.637**	-13.46**	-9.052**	-15.72**	-47.18**	-33.39**	0	-10.21**	-23.18**	-24.21**	1.075
XSids 7	8.486**	8.747**	4.229**	5.806**	-7.627**	-3.070**	14.15**	8.356**	-2.824**	1.855**	-8.486**	-9.473**	20.29**	-13.16**
XGemmieza3	1.843**	20.14**	8.188**	-7.758**	-0.833**	3.182**	36.23**	23.26**	41.10**	-5.456**	4.766**	41.77**	31.59**	11.57**
XGemmieza7	4.848**	28.57**	-23.04**	-30.77**	1.324**	0.575**	18.20**	-16.31**	15.69**	-4.892**	1.820**	16.91**	-18.70**	28.89**
Sakha206XGiza 164	9.391**	3.103**	-35.61**	-43.51**	-11.91**	-6.709**	-36.63**	-49.69**	-41.21**	-0.559**	-10.51**	-46.45**	-70.36**	8.217**
XGiza 168	-2.246**	5.806**	0	2.528**	0.789**	0.605**	0.699**	12.94**	-5.046**	-5.682**	1.005**	9.190**	25.14**	-15.50**
XGiza 170	6.287**	5.806**	-21.56**	-28.58**	-7.317**	0.756**	5.187**	0.769	-6.777**	4.583**	-8.655**	-48.45**	-63.29**	-12.98**
XSids1	12.64**	20.42**	37.34**	46.06**	-0.502**	-1.955**	23.71**	9.542**	19.39**	-4.590**	-2.318**	-10.12**	52.07**	-6.932**
XSids7	-2.895**	6.302**	-2.404**	-15.48**	-3.515**	-5.132**	0.534*	4.368*	-5.028**	-11.24**	-2.009**	7.004**	14.46**	-8.878**
XGemmieza3	-7.410**	26.22**	-14.16**	-20.14**	21.45**	3.867**	88.23**	68.37**	103.7**	-17.04**	23.42**	5.668**	-9.403**	17.25**
XGemmieza7	-2.084**	21.72**	75.76**	81.10**	13.85**	5.310**	56.43**	35.23**	61.03**	-14.38**	14.45**	-3.927**	97.45**	11.90**
Giza164XGiza168	3.592**	-4.156**	42.41**	50.73**	7.803**	-1.709**	-9.132**	-5.041*	-20.41**	-9.497**	7.107**	0.388**	76.66**	-19.19**
XGiza170	-2.452**	-4.117**	-15.12**	-14.12**	10.82**	1.154**	24.84**	3.266	20.72**	-8.548**	9.466**	22.30**	20.54**	-4.058*
XSids1	-0.991**	2.197**	34.64**	37.85**	3.033**	-0.425**	21.63**	6.395**	19.55**	-5.754**	6.128**	-2.484**	40.74**	11.90**
XSids7	-1.349**	4.863**	-66.34**	-61.02**	39.47**	0.556**	83.56**	41.48**	83.24**	-28.10**	45.07**	105.0**	-18.59**	19.34**
XGemmieza3	18.30**	11.89**	-35.12**	-27.68**	-13.26**	-12.09**	-20.87**	-40.66**	-27.59**	0.559**	-11.92**	1.009**	-27.51**	8.551**
XGemmieza7	0.809**	16.52**	-3.410**	-2.831**	5.878**	0	-4.197**	-40.47**	-7.455**	-5.419**	4.715**	-7.916**	-6.964**	53.29**

Table 1: Cont.

Genotypes	Heading date (days)	Plant height (cm)	Number of tillers / plant	Number of Productive tillers	Main culm spike length (cm)	No. of spikelets /main culm spike	Main culm spike weight (gm)	No. of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length (cm)	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Giza168XGiza170	-3.733**	3.294**	-28.38**	-31.98**	3.561**	-1.729**	15.74**	15.94**	11.17**	-5.511**	1.699**	11.76**	-8.103**	-1.739
XSids1	-1.809**	1.142**	-3.053**	-2.543**	-4.660**	-4.377**	-8.821**	-17.50**	-21.26**	-0.739**	-0.817**	12.78**	15.10**	-4.878*
XSids7	-12.56**	8.667**	-33.62**	-38.07**	-1.212**	1.600**	-19.62**	-12.34**	-31.26**	2.079**	-1.322**	11.41**	-32.62**	-21.28**
XGemmieza3	-3.900**	27.60**	-29.26**	-30.97**	2.424**	2.594**	-10.82**	-15.49**	-25.00**	0	2.219**	5.232**	-27.39**	-8.309**
XGemmieza7	1.584**	-3.431**	-53.71**	-53.82**	-6.212**	-4.756**	-23.57**	-16.34**	-36.01**	1.603**	-4.050**	14.35**	-47.39**	-21.42**
Giza170XSids1	17.06**	4.392**	-16.78**	-2.871**	-17.68**	-12.16**	-15.59**	-27.88**	-21.32**	5.565**	-18.20**	-35.27**	-35.32**	-9.943**
XSids7	2.475**	8.564**	-1.204**	-7.103**	-0.611**	-3.509**	0.941**	7.074**	0.764**	-5.056**	-1.618**	-7.980**	-3.454**	-8.769**
XGemmieza3	6.327**	20.81**	-9.592**	-9.299**	4.773**	-0.591**	23.06**	4.452*	27.17**	-5.774**	-0.405*	-7.196**	-17.73**	20.66**
XGemmieza7	3.684**	12.93**	-22.76**	-30.08**	-8.689**	1.903**	15.24**	1.930	6.363**	9.489**	-6.553**	3.206**	-26.40**	-11.75**
Sids1XSids7	14.49**	4.040**	-17.46**	-29.69**	-11.76**	-7.055**	-24.06**	-41.96**	-38.64**	3.202**	-8.987**	-42.30**	-48.21**	-11.02**
XGemmieza3	7.556**	21.55**	35.29**	56.73**	-6.435**	-1.530**	15.45**	-3.385	13.47**	4.819**	-2.288**	3.884**	81.65**	-7.462**
XGemmieza7	5.909**	10.79**	8.491**	16.07**	9.468**	2.295**	19.11**	5.598**	17.95**	-7.557**	8.497**	19.25**	35.17**	3.542
Sids7XGemmieza3	-0.310	20.17**	-36.74**	-34.84**	3.182**	-3.509**	70.14**	23.69**	32.83**	-9.382**	3.944**	20.43**	0.630	1.071
XGemmieza7	0.290	25.63**	2.422**	4.509**	6.070**	4.386**	26.94**	1.174**	20.86**	-0.739**	1.820**	12.11**	27.99**	11.08**
Gemmieza3XGemmieza7	4.761**	20.28**	-2.418**	2.098**	7.046**	6.770**	19.11**	13.77**	17.11**	-2.671**	5.916**	9.866**	13.26**	-6.845**
LSD 0.05	0.509	0.828	0.407	0.469	0.228	0.269	0.493	3.014	0.286	0.031	0.326	0.282	1.190	3.946
LSD 0.01	0.674	1.097	0.539	0.821	0.302	0.357	0.653	5.185	0.379	0.042	0.431	0.374	1.576	5.227

*, ** Significant at 0.05 and 0.01 probability levels respectively

12.56% relative to the respective better parent values. The best cross of these superior eleven crosses was Giza 168 X Sids 7 which came to heading after 77.3 days from sowing and eleven days earlier than its early parent Giza 168 (88.4 days) Table (2). Therefore, it could be concluded that these eleven crosses would be of interest in a wheat breeding programme for earliness. These results are in conformity with those previously obtained by Hendawy (1994b), Hewezi (1996), EL-Sayed (1997), Hendawy (1998), Saad (1999), EL-Seidy and Hamada (2000), Comber (2001) and Seleem (2001). Concerning plant height, only three hybrid combinations showed useful heterosis which ranged from -3.431% to - 4.156% relative to their respective better parents. Useful heterotic effects were previously obtained for plant height by AL-Kaddoussi and Hassan (1991), Seleem (1993), Hendawy (1994 a), Hewezi (1996), EL-Sayed (1997), Hendawy (1998), Saad (1999), Afiah *et al.*,(2000), EL-Hosary *et al.*,(2000), EL-Seidy and Hamada (2000), Comber (2001), Seleem (2001), Darwish and Ashoush (2003) and Seleem (2006). The results obtained for number of productive tillers per plant were, in general, similar to those for number of tillers per plant, and the later trait are not presented . Eleven hybrid combinations had significantly more productive tillers per plant than their respective better parents . This useful heterosis ranged from 2.098% to 81.1% over the respective better parent . Heterosis for number of productive tillers per plant was also detected by Hendawy (1990), AL-Kaddoussi and Hassan (1991), Hassan and Abd El-Monieum (1991), Seleem (1993), Hendawy (1994a), Hewezi (1996), EL-Sayed (1997), Afiah *et al.* (2000), Comber (2001), Darwish and Ashoush (2003), Bayoumi (2004) and Seleem (2006).Sixteen of the thirty six hybrid combinations studied were found to show highly significant useful heterotic effects for main culm spike length which varied from 0.789% to 39.47% in comparison with their respective better parents. Heterosis was previously found by Seleem (1993), Hendawy (1994a), Hewezi (1996), EL-Sayed (1997), Comber (2001) and Seleem (2001). Concerning number of spikelets per main culm spike, sixteen crosses exhibited highly significant desirable heterosis which ranged from 0.556% to 6.77% over the better parent. Heterosis for spikelets per main culm spike was previously detected by Hendawy (1990), Seleem (1993), Hendawy (1994a), Hendawy (1998), Saad (1999) and Comber (2001). Twenty three crosses exhibited highly significant useful heterosis for main culm spike weight, this increase varied from 0.534% to 88.23% over the respective better parent. The most desirable heterosis was detected by the cross Sakha 206 X Gemmieza 3. Eighteen out of thirty six hybrid combinations investigated had significantly more grains per main culm spike than their respective higher parents. The

Table (2): The genotypes mean performance for all characters studied.

Genotypes	Heading date (days)	Plant height	Number of tillers / plant	Number of Productive tillers	Main culm spike length	No.of spikelets / main culm spike	Main culm spike weight (gm)	No.of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Sakha 93	85.20	85.40	4.067	3.867	11.03	20.77	3.127	46.57	2.450	1.833	10.08	2.143	8.177	53.96
Sakha 206	86.37	99.90	5.437	4.633	13.94	22.50	3.747	57.23	3.043	1.613	12.94	2.470	9.890	52.94
Giza 164	81.57	122.7	6.833	5.900	13.10	23.40	4.360	69.43	3.407	1.790	11.76	2.577	14.36	49.26
Giza 168	88.40	117.9	7.633	6.567	13.20	23.13	5.147	66.70	4.360	1.760	12.10	2.217	14.44	64.99
Giza 170	91.73	109.3	5.567	4.667	13.12	22.00	3.933	53.23	3.143	1.680	12.36	2.807	12.45	59.64
Sids 1	80.73	113.8	2.967	2.600	13.52	23.53	3.753	67.07	2.917	1.743	12.24	2.317	5.830	43.78
Sids 7	94.93	97.27	5.533	5.167	12.85	22.80	3.513	54.57	2.833	1.780	11.43	1.840	8.887	52.01
Gemmieza 3	87.17	94.20	3.967	3.233	13.20	22.00	3.053	43.77	2.390	1.667	12.17	2.217	6.810	55.08
Gemmieza 7	89.57	102.9	5.500	4.767	12.84	22.60	3.957	62.17	3.097	1.760	12.09	2.230	10.18	49.69
Sakha93XSakha 206	92.10	98.03	8.133	7.400	13.40	22.33	4.980	77.20	3.843	1.670	11.97	2.453	19.01	49.77
XGiza 164	92.23	96.37	5.300	4.533	11.71	22.23	4.067	61.93	3.363	1.903	11.02	2.903	12.69	54.12
XGiza 168	89.90	107.6	6.400	5.400	12.56	23.40	5.300	71.23	3.990	1.863	11.74	2.437	12.66	55.91
XGiza 170	92.80	97.83	4.600	4.167	12.43	22.43	3.197	49.97	2.257	1.810	11.51	1.807	7.300	44.97
XSids 1	87.10	108.9	4.533	3.533	11.70	21.40	3.163	35.43	1.943	1.833	10.99	1.780	6.197	54.54
XSids 7	92.43	92.87	5.767	5.467	11.87	22.10	4.010	59.13	2.753	1.867	10.46	1.940	10.69	46.86
XGemmieza3	86.77	102.6	4.400	3.567	13.09	22.70	4.260	56.17	3.457	1.733	12.75	3.143	10.76	61.45
XGemmieza7	89.33	109.8	4.233	3.300	13.01	22.73	4.677	52.03	3.583	1.747	12.31	2.607	8.276	69.55
Sakha206XGiza 164	89.23	103.0	4.400	3.333	12.28	21.83	2.763	34.93	2.003	1.780	11.58	1.380	4.257	57.29
XGiza 168	84.43	105.7	7.633	6.733	14.05	23.27	5.183	75.33	4.140	1.660	13.07	2.697	18.07	54.92
XGiza 170	91.80	105.7	4.367	3.333	12.92	22.67	4.137	57.67	2.930	1.757	11.82	1.447	4.570	51.90
XSids1	90.93	120.3	7.467	6.767	13.87	23.07	4.643	73.47	3.633	1.663	12.64	2.220	15.04	49.27
XSids7	83.87	103.4	5.400	4.367	13.45	21.63	3.767	59.73	2.890	1.580	12.68	2.643	11.32	48.24
XGemmieza3	79.97	118.9	4.667	3.700	16.93	23.37	7.053	96.36	6.197	1.383	15.97	2.610	8.960	64.58
XGemmieza7	84.57	121.6	9.667	8.633	15.87	23.80	6.190	84.07	4.987	1.507	14.81	2.373	20.10	59.24

Table 2: Cont.

Genotypes	Heading date (days)	Plant height (cm)	Number of tillers / plant	Number of Productive tillers	Main culm spike length (cm)	No.of spikelets / main culm spike	Main culm spike weight (gm)	No.of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length (cm)	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Giza164XGiza168	84.50	113.0	10.87	9.900	14.23	23.00	4.677	65.93	3.470	1.620	12.96	2.587	25.51	52.52
XGiza170	79.57	104.8	5.800	5.067	14.54	23.67	5.443	71.67	4.113	1.637	13.53	3.433	17.31	57.22
XSids1	79.93	116.3	9.200	8.133	13.93	23.43	5.303	73.87	4.073	1.687	12.99	2.513	20.21	55.12
XSids7	80.47	102.0	2.300	2.300	18.27	23.53	8.003	98.23	6.243	1.287	17.06	5.283	11.69	62.07
XGemmieza3	96.50	105.4	4.433	4.267	11.45	20.57	3.450	41.20	2.467	1.800	10.72	2.603	10.41	59.79
XGemmieza7	82.23	119.9	6.600	5.733	13.87	23.40	4.177	41.33	3.153	1.693	12.66	2.373	13.36	76.17
Giza168XGiza170	85.10	122.9	5.467	4.467	13.67	22.73	5.957	77.33	4.847	1.663	12.57	3.137	13.27	63.86
XSids1	79.27	115.1	7.400	6.400	12.89	22.50	4.693	55.33	3.433	1.747	12.14	2.613	16.62	61.82
XSids7	77.30	105.7	5.067	4.067	13.04	23.50	4.137	58.47	2.997	1.817	11.94	2.470	9.730	51.16
XGemmieza3	83.77	120.2	5.400	4.533	13.52	23.73	4.590	56.37	3.270	1.760	12.44	2.333	10.49	59.59
XGemmieza7	89.80	99.37	3.533	3.033	12.38	22.03	3.934	55.80	2.790	1.783	11.61	2.550	7.597	51.07
Giza170XSids1	94.50	114.1	4.633	4.533	11.13	20.67	3.320	48.37	2.473	1.840	10.11	1.817	8.053	53.71
XSids7	94.00	105.6	5.500	4.800	13.02	22.00	3.970	58.43	3.167	1.690	12.16	2.583	12.02	54.41
XGemmieza3	93.03	113.8	5.033	4.233	13.83	21.87	4.840	55.60	3.997	1.583	12.31	2.605	10.28	71.96
XGemmieza7	92.87	116.2	4.300	3.333	11.98	23.03	4.560	63.37	3.343	1.927	11.55	2.897	9.163	52.63
Sids1XSids7	92.43	101.2	4.567	3.633	11.93	21.87	2.850	38.93	1.790	1.837	11.14	1.337	4.603	46.28
XGemmieza3	86.83	114.5	5.367	5.067	12.65	23.17	4.333	64.80	3.310	1.837	11.96	2.407	12.37	50.97
XGemmieza7	85.50	114.0	5.967	5.533	14.80	24.07	4.713	70.93	3.653	1.627	13.28	2.763	13.76	51.45
Sids7XGemmieza3	86.90	113.2	3.500	3.367	13.62	22.00	5.977	67.50	3.763	1.613	12.65	2.670	8.943	55.67
XGemmieza7	89.83	122.2	5.667	5.400	13.63	23.80	5.023	62.90	3.743	1.747	12.31	2.500	13.03	57.77
Gemmieza3XGemmieza7	91.23	113.3	5.367	4.867	14.13	24.13	4.713	70.73	3.627	1.713	12.89	2.450	11.53	51.31
LSD $_{0.05}$	1.61	0.829	0.407	0.470	0.229	0.272	0.492	3.916	0.286	0.000	0.325	0.281	1.196	3.948
LSD $_{0.01}$	2.13	1.098	0.539	0.623	0.304	0.366	0.652	5.187	0.378	0.000	0.436	0.371	1.576	5.229

desirable heterosis ranged from 1.174% to 68.37% over the respective better parent. Also, the most desirable heterosis was detected by the cross Sakha 206 X Gemmieza 3. Similar results were previously obtained by Hendawy (1990), Hewezi (1996), EL-Sayed (1997), Hendawy (1998) and Comber (2001). As for main culm spike density, eleven crosses out of the thirty six hybrid combinations studied showed highly significant useful heterosis which ranged from 0.559% to 9.489% in comparison with their better parent. Sixteen out of the thirty six hybrid combinations showed highly significant useful heterotic effects for spike length . This heterosis was varied from 1.005% to 45.07% over the respective better parent. These results are in harmony with those previously obtained by Hendawy (1990), AL-Kaddoussi and Hassan (1991), EL-Seidy and Hamada (2000), Hendawy (2003), Bayoumi (2004) and Seleem (2006). Twenty two crosses of the thirty six hybrid combinations studied were found to have significantly more spike yield than their corresponding better parents. This useful heterosis ranged from 0.388% to 105% over their respective better parent and the most desirable heterosis was detected by the cross Giza 164 X Sids 7 . Useful heterosis was previously detected by Hewezi (1996), EL-Sayed (1997), Hendawy (1998), Saad (1999) and Comber (2001). Fifteen hybrid combinations showed highly significant useful heterosis for grain weight per plant which varied from 13.26% to 97.45% over the respective better parent. The most desirable heterosis was detected by the cross Sakha 206 X Gemmieza 7 . Heterotic effects were previously detected by Dencic and Borojevic (1992), EL-Hennawy (1995), AL-Gazar (1999), Esmail and Kattab (2002) and Bayoumi (2004). As for 1000-grain weight, eleven of the thirty six hybrid combinations investigated had significantly heavier grains than that of their respective better parents . This useful heterosis ranged from 8.217% to 53.29% over the respective better parent . The most desirable heterosis (53.29%) was detected by the cross Giza 164 X Gemmieza 7, Significant heterosis was also found by Saad (1999), Afiah *et al.* (2000), Hendawy (2003) and Seleem (2006). It could be concluded that , the hybrid combination Sakha 206 X Gemmieza 7 would be of practical interest because of its superiority in eleven of the fourteen characters studied i.e. heading date, number of tillers per plant, number of productive tillers per plant, main culm spike length, number of spikelets per main culm spike, main culm spike weight, number of grains per main culm spike, grain weight of main culm spike, spike length, grain weight per plant and 1000-grain weight.

The ordinary analysis of variance and combining ability analysis for all characters studied are presented in Table (3). The genotypes, parents and the

Table (3): Mean squares estimates of ordinary analysis and combining ability analysis for all characters studied.

Source of variance	D.F.	Heading date (days)	Plant height (cm)	Number of tillers / plant	Number of Productive tillers	Main culm spike length (cm)	No. of spikelets /main culm spike	Main culm spike weight (gm)	No. of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length (cm)	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Rep.	2	0.008	0.238	0.013	0.156	0.004	0.035	0.019	29.89	0.542	0.000	0.007	0.166	0.858	14.94
Genotypes	44	73.39**	250.1**	8.78**	7.630**	5.539**	2.355**	3.425**	588.6**	2.615**	0.047	4.943**	1.127**	60.58**	142.6**
Parent	8	95.88**	499.6**	11.89**	9.109**	14.11**	4.638**	6.243**	752.04**	4.027**	0.093	13.65**	3.271**	49.82**	80.78**
Crosses	35	70.32**	197.5**	8.243**	7.510**	3.734**	1.897**	2.871**	529.5**	2.361**	0.038	3.068**	0.659**	64.75**	141.6**
P. VS. C.	1	0.684**	96.20**	2.716**	0.001	0.159**	0.125**	0.253	1349.6**	0.194*	0.001	0.898**	0.387**	0.016	670.6**
GCA	8	39.57**	243.8**	2.286**	1.744**	6.073**	1.328**	2.942**	405.5**	1.849**	0.055	5.771**	0.764**	18.67**	74.62**
SCA	36	21.11**	47.73**	3.069**	2.721**	0.907**	0.664**	0.742**	149.7**	0.654**	0.007	0.731**	0.289**	20.53**	41.51**
Error	88	0.098	0.261	0.063	0.084	0.020	0.028	0.092	5.826	0.031	0.000	0.040	0.030	0.538	5.921
G.C.A / S.C.A		1.88	5.11	0.745	0.641	6.696	2	3.965	2.827	2.709	7.857	7.895	2.644	0.909	1.798

*, ** Significant at 0.05 and 0.01 probability levels respectively

resultant crosses mean square estimates were found to be highly significant for all traits studied except main culm spike density, indicating an overall differences among these populations, however, there is no need to proceed further in the combining ability analysis concerning main culm spike density. Parent vs. crosses mean squares as an indication to average heterosis overall crosses were found to be highly significant for all traits except for number of productive tillers per plant, main culm spike weight and grain weight per plant

Both general and specific combining ability variances were found to be highly significant for all traits under investigation. This would indicate the importance of both additive and non-additive genetic variance in determining the performance of all characters studied. The question remains would be about the relative importance of both general and specific combining ability variances, therefore GCA / SCA ratio was used to clarify the nature of the genetic variance involved. With the exception of number of tillers per plant, number of productive tillers per plant and grain weight per plant, the general combining ability / specific combining ability ratio were found to be greater than unity, indicating that additive and additive X additive types of gene action were of greater importance in the inheritance of these traits.

It is therefore could be concluded that the presence of large amount of additive effects, suggest the potentiality for obtaining further yield and yield components improvement. Also, selection procedures based on the accumulation of additive effect would be successful in improving all characters studied. However, to maximize selection advance, procedures which are known to be effective in shifting gene frequency when both additive and non-additive genetic variance are involved, would be preferred.

Both general and specific combining ability variances were previously detected by Hendawy (1994a) and Moussa (2005) for heading date, Hewezi (1996), EL-Hosary *et al.*, (2000) and EL-Sayed and Moshref (2005) for plant height, Hewezi (1996) for number of productive tillers, Hendawy (1994b) and Comber (2001) for main culm spike length, Hewezi (1996) for number of spikelets per main culm spike, Hewezi (1996) for number of grains per main culm spike, Hendawy (1994b) and Comber (2001) for grain weight per main culm spike , Zaied (1995), El-Seidy and Hamada (2000) and Joshi *et al.*, (2004) for spike length, Seleem (1993) and Moussa (2005) for grain weight per spike, Hendawy (1994c), Saad (1999) and EL-Sayed and Moshref (2005) for grain weight per plant and EL-Hennawy (1995) and Hamada (2003) for 1000-grain weight.

Estimates of the general combining ability effects (ĝi) for the individual parental lines in each trait are given in Table (4). General combining ability effects computed herein were found to be differ significantly from zero in most crosses. High positive values of general combining ability effects would be of interest in most traits studied. On the contrary, for heading date and plant height, high negative values would be useful from the wheat breeder point of view. The four wheat cultivars Sakha 206, Sids 1, Sids 7 and Gemmieza 3 showed highly significant negative general combining ability effects for heading date, revealing that these four varieties could be considered as excellent combiners for developing early genotypes. As for plant height, the three wheat varieties Sakha 93, Giza 168 and Giza 170 exhibited highly significant negative general combining ability effects prove to be good combiner for shortness because lodging resistance in wheat has usually been observed to be negative correlated with plant height. As for number of both tillers and productive tillers , the three wheat varieties Giza 168, Sids 1 and Sids 7 exhibited highly significant general combining ability effects proved to be good combiners in this concern. The four wheat varieties Sakha 206, Sids 1, Sids 7 and Gemmieza 7 exhibited highly significant positive general combining ability effects, proving to be good combiners for main culm spike length. Concerning number of spikelets per main culm spike, five cultivars i.e. Sakha 206, Giza 164, Sids 1, Sids 7 and Gemmieza 7 showed highly significant general combining ability effects proving to be good combiners in this concern. As for main culm spike weight, Sakha 206, Sids 7 and Gemmieza 7 proved to be the best combiners in this respect. The four wheat varieties, Giza 164, Sids 1, Sids 7 and Gemmieza 7 proved to be good combiners for number of grains per main culm spike. With regard to grain weight per main culm spike, only two out of nine wheat varieties showed highly significant general combining ability effects proving to be good combiners in this concern. Sakha 206, Sids 1 and Sids 7 exhibited highly significant estimates of general combining ability effects for spike length proving to be good combiners in this respect. As for grain weight per spike, the only wheat cultivar showed highly significant estimates of general combining ability effects was Sids 7 proving to be good combiner for grain yield per spike. Concerning grain yield per plant, the three wheat cultivars Giza 168, Sids 1 and Sids 7 showed highly significant estimates of general combining ability effects proving to be good combiners for this trait. The three wheat varieties Sakha 206, Sids 7 and Gemmieza 3 exhibited highly significant general combining ability effects for 1000-grain weight proving to be good combiners in this respect.

Table (4): Estimates of general combining ability effects of the nine wheat varieties studied for all characters studied .

Genotypes	Heading date (days)	Plant height (cm)	Number of tillers / plant	Number of productive tillers	Main culm spike length (cm)	No. of spikelets /main culm spike	Main culm spike weight (gm)	No. of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length (cm)	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Sakha 93	1.655**	-7.923**	-0.353**	-0.262**	-0.747**	-0.696**	-0.583**	-6.050**	-0.327**	0.032**	-0.640**	-0.002	-0.824**	0.018
Sakha 206	-1.127**	2.947**	-0.008	-0.165**	0.336**	0.119**	0.083*	-0.368	0.203**	-0.033**	0.271**	0.052	-0.380**	4.425**
Giza 164	0.042	2.987**	-0.235**	-0.307**	-0.052*	0.171**	-0.125*	1.113**	-0.018	0.018**	0.006	-0.112**	-1.178**	-1.435**
Giza 168	0.758**	-4.735**	0.965**	0.878**	-0.227**	-0.241**	-0.322**	-2.526**	-0.299**	0.006*	-0.278**	-0.227**	1.739**	-2.662**
Giza 170	0.648**	-5.386**	-0.244**	-0.219**	-0.699**	-0.008**	-0.254**	-2.202**	-0.334**	0.092**	-0.688**	-0.195**	-1.033**	-3.743**
Sids 1	-0.239**	2.862**	0.444**	0.317**	0.213**	0.346**	0.030	0.962*	0.028	-0.009**	0.228**	-0.126**	0.421**	0.379
Sids 7	-4.112**	0.741**	0.144**	0.208**	1.681**	0.295**	1.250**	14.34**	0.973**	-0.163**	1.666**	0.658**	2.504**	1.102**
Gemmieza 3	-0.224**	4.787**	-0.256**	-0.140**	-0.572**	-0.287**	-0.181**	-6.199**	-0.220**	0.047**	-0.581**	-0.045	-0.470**	3.000**
Gemmieza 7	2.600**	3.720**	-0.456**	-0.310**	0.067**	0.301**	0.101*	0.935*	-0.005	0.010**	0.015	-0.004	-0.778**	-1.082**
LSD (gi) $_{0.05}$	0.101	0.167	0.0815	0.093	0.0457	0.0537	0.0994	0.7868	0.0576	0.0060	0.0656	0.0576	0.238	0.793
LSD (gi) $_{0.01}$	0.134	0.221	0.108	0.124	0.0605	0.0711	0.1316	1.0423	0.0763	0.0079	0.0869	0.0763	0.316	1.050
LSD (gi – gi) $_{0.05}$	0.153	0.250	0.123	0.141	0.0696	0.0815	0.1490	1.1802	0.0854	0.0099	0.0974	0.0854	0.360	1.190
LSD (gi –gi) $_{0.01}$	0.203	0.332	0.163	0.187	0.0921	0.1079	0.1974	1.5634	0.1132	0.0132	0.1290	0.1132	0.476	1.577

*, ** Significant at 0.05 and 0.01 probability levels respectively.

Estimates of the specific combining ability effects ($\hat{S}i$) for the thirty six hybrid combinations studied are presented in Table (5). Sixteen of the thirty six hybrid combinations showed highly significant specific combining ability effects (SCA) for heading date, only three of these superior crosses showed desirable heterosis i.e. Sakha 206 X Sids 7, Giza 168 X Giza 170 and Giza 168 X Gemmieza 3. It is of interest to mention that the three parental cultivars Sakha 206, Sids 7 and Gemmieza 3 which were involved in two of these superior crosses were found to be the best combiners for earliness, however, the other two cultivars in these three superior crosses were found to be the poorest combiners in this respect.

Fourteen of the thirty six hybrid combinations studied were detected to show highly significant negative SCA effects for plant height. Only three of these superior fourteen crosses were previously found to show highly significant useful heterosis for plant height i.e. Giza 164 X Giza 168, Giza 164 X Giza 170 and Giza 168 X Gemmieza 7. The two parental cultivars Giza 168 and Giza 170 were found to be the best general combiners for plant height, however, the other two parental cultivars Giza 164 and Gemmieza 7 were found to be among the poorest general combiners for plant height. As for number of both tillers and productive tillers, eleven hybrid combinations showed highly significant desirable SCA effects, only one of these superior eleven crosses Gemmieza 3 X Gemmieza 7 was found to show desirable heterosis for these two traits. It is of interest to mention that the two wheat cultivars Gemmieza 3 and Gemmieza 7 were found to be among the poorest general combiners for number of both tillers and productive tillers per plant.

Sixteen crosses exhibited highly significant SCA effects for main culm spike length, seven of them were previously found to show pronounced heterosis and some of these crosses comprised both good general combiners and poor general combiners. Concerning number of spikelets per main culm spike, twenty of the thirty six hybrid combinations studied exhibited highly significant SCA effects. Some of these superior crosses were found to show desirable heterosis for spikelets number. As for main culm spike weight, ten hybrid combinations showed highly significant estimates of specific combining ability effects i.e. Sakha 206 X Giza 170, Sakha 206 X Sids 7, Giza 164 X Sids 7 and Gemmieza 3 X Gemmieza 7. Three parental cultivars from the six parental cultivars which were involved in these superior crosses were found to be good combiners for main culm spike weight. Concerning number of grains per main culm spike, twelve crosses showed highly significant estimates of specific combining ability effects, six of these superior crosses were found to show useful heterosis. Some of

Table (5): Estimates of specific combining ability effects of the thirty six hybrid combinations for all characters studied.

Genotypes	Heading date (days)	Plant height	Number of tillers / plant	Number of productive tillers	Main culm spike length	No .of spikelets / main culm spike	Main culm spike weight (gm)	No. of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Sakha93XSakha 206	-1.688**	-3.766**	0.229	0.208	1.054**	0.401**	-0.212	2.287	-0.240*	-0.103**	1.006**	-0.051	-0.484	-7.067**
XGiza 164	-0.824**	14.23**	2.656**	2.284**	0.694**	0.983**	1.396**	10.27**	1.299**	-0.007	0.431**	-0.141	4.864**	10.84**
XGiza 168	4.994**	1.282**	-0.644**	-0.301	0.521**	1.062**	-0.041	1.778	0.053	0.024*	0.052	-0.402**	-3.606**	-0.913
XGiza 170	2.403**	1.034**	0.332*	0.183	-0.140	0.282**	0.445*	8.820**	0.607**	0.062*	0.052	0.629**	2.973**	2.275
XSids 1	-2.175**	-0.981**	-1.256**	-1.340**	0.324**	0.374**	0.355*	-0.110	0.349**	-0.007	0.859**	0.800**	-0.472	5.491**
XSids 7	-1.200**	1.940**	0.044	-0.431**	-0.787**	-0.641**	-1.360**	-9.916**	-1.162**	-0.007	-0.649**	-0.484**	-1.941**	-8.450**
XGemmieza3	7.543**	-0.105	-0.522**	-0.182	-0.531**	-1.126**	-0.245	-7.916**	-0.393**	0.004	-0.355**	0.179	0.126	1.212
XGemmieza7	2.219**	1.161**	0.744**	0.521**	0.404**	-0.281**	-0.006	2.184	0.092	-0.070**	0.483**	0.118	2.047**	-0.093
Sakha206XGiza 164	5.292**	-5.242**	0.244	0.287	-0.484**	-0.965**	-0.483**	-8.677**	-0.449**	-0.022*	-0.219*	0.396**	2.426**	1.086
XGiza 168	0.010	-12.65**	-2.556**	-2.331**	-0.209**	-0.533**	-1.167**	-14.70**	-0.922**	-0.024*	-0.123	-0.079	-6.127**	-2.247
XGiza 170	2.852**	1.398**	1.067**	0.933**	-0.354**	0.613**	1.012**	12.44**	0.713**	0.067**	-0.148	0.109	2.698**	-0.343
XSids1	3.172**	-4.684**	-1.768**	-1.704**	-0.832**	-0.408**	0.105	-9.925**	-0.055	0.071**	-0.488**	0.210*	-3.350**	9.177**
XSids7	-2.321**	6.604**	-1.035**	-1.195**	1.616**	0.277**	1.260**	20.97**	1.613**	-0.138**	1.731**	-0.571**	-4.742**	3.482**
XGemmieza3	-3.942**	3.558**	1.299**	1.187**	0.802**	0.892**	-0.184	-13.47**	-0.237*	-0.038**	0.670**	-0.104	2.632**	13.81**
XGemmieza7	4.034**	-1.542**	-0.068	-0.143	0.131	-1.229**	0.198	-6.332**	0.391**	-0.111**	-0.275*	0.088	-0.140	13.05**
Giza164XGiza168	1.240**	-3.960**	-0.795**	-0.655**	-0.180*	-0.005	-0.055	2.214	0.007	0.018	0.062	0.098	-1.956**	-1.776
XGiza170	4.582**	-8.408**	-0.486**	-0.158	-0.116	-0.405**	-0.883**	-10.31**	-0.798**	-0.018	-0.104	-0.358**	-2.067**	-5.415**
XSids1	1.904**	-11.52**	-1.374**	-1.528**	-1.177**	-1.359**	-1.600**	-28.51**	-1.413**	0.053**	-0.953**	-0.853**	-6.565**	2.778*
XSids7	1.109**	9.198**	4.193**	3.881**	0.938**	0.659**	0.605**	7.253**	0.625**	-0.066**	0.843**	-0.644**	7.193**	4.003**
XGemmieza3	-2.245**	6.452**	0.393**	0.063	0.990**	0.174**	1.804**	21.05**	1.678**	-0.119**	0.842**	0.822**	3.340**	6.728**
XGemmieza7	2.698**	0.819**	-0.574**	-0.901**	-1.331**	-0.114	0.126	-0.047	-0.041	0.181**	-0.766**	0.542**	-0.459	-0.416

Table (5): Cont.

Genotypes	Heading date (days)	Plant height (cm)	Number of tillers / plant	Number of Productive tillers	Main culm spike length (cm)	No .of spikelets / main culm spike	Main culm spike weight (gm)	No. of grains / main culm spike	Grain weight / main culm spike (gm)	Main culm spike density	Spike length (cm)	Grain weight / spike (gm)	Grain weight / plant (gm)	1000-grains weight (gm)
Giza168XGiza170	-1.833**	10.38**	-1.753**	-1.976**	-0.674**	-1.026**	-0.720**	-21.20**	-0.831**	0.017	-0.344**	-0.269**	-8.087**	5.374**
XSids1	-3.611**	-1.102**	0.659**	0.687**	0.765**	0.486**	1.017**	15.53**	1.004**	-0.055*	0.817**	0.579**	4.335**	1.634
XSids7	0.328	8.352**	4.193**	3.963**	-0.520**	0.271**	-0.712**	-7.241**	0.811**	0.059**	-0.731**	-0.315**	9.689**	-1.490
XGemmieza3	-6.793**	6.440**	1.126**	0.812**	0.393**	0.353**	0.737**	2.693*	0.546**	-0.024*	0.702**	0.415**	3.773**	5.915**
XGemmieza7	1.549**	-6.460**	-1.507**	-1.785**	-1.206**	-0.868**	-1.388**	-20.84**	-1.314**	0.103**	-0.893**	-0.903**	-7.936**	-5.546**
Giza170XSids1	3.864**	-0.384	-1.398**	-1.616**	0.103	-0.347**	-0.098	-2.459	-0.171	-0.044**	-0.020	-0.703**	-6.396**	-0.302
XSids7	-4.497**	0.770**	0.335*	0.277	0.261**	0.704**	-0.013	-1.832	0.067	-0.010	0.249*	0.499**	4.258**	4.297**
XGemmieza3	-10.65**	-2.308**	0.002	-0.425**	1.007**	1.119**	0.112	5.502**	0.144	-0.040**	0.909**	0.239*	-0.345	-3.664**
XGemmieza7	-3.942**	7.525**	0.502**	0.745**	-0.017**	0.198*	0.028	4.702**	0.241*	0.017	0.334**	0.135	2.603**	0.228
Sids1XSids7	-3.242**	4.055**	3.047**	2.757**	-1.260**	0.116	-0.436**	-2.795*	-0.334**	0.141**	-1.200**	-0.490**	5.703**	-1.923
XGemmieza3	-3.296**	3.943**	-0.353*	-0.495**	0.576**	0.998**	0.282	0.238	0.056	0.005	0.490**	0.033	-1.039**	0.652
XGemmieza7	-4.387**	-1.190**	0.414**	0.075	1.221**	0.744**	0.124	7.672**	0.223*	-0.092**	0.735**	0.423**	2.539**	-3.409*
Sids7XGemmieza3	6.609**	-14.80**	-1.919**	-1.886**	-2.029**	-0.652**	-1.595**	-13.70**	-1.369**	0.182**	-1.771**	-0.534**	-6.016**	-8.602**
XGemmieza7	0.885**	0.131	-1.753**	-1.382**	-1.427**	-1.272**	0.166	-9.135**	-0.612**	0.049**	-1.330**	-0.455**	-4.360**	0.083
Gemmieza3XGemmieza7	-0.069	5.052**	0.814**	0.999**	0.839**	1.110**	0.645**	6.799**	0.561**	-0.028**	0.577**	0.078	2.697**	0.285
LSD (sii) 0.05	0.3298	0.5365	0.2843	0.3040	0.1470	0.1749	0.3199	2.5314	0.1848	0.0199	0.2106	0.1826	0.7690	2.5533
LSD (sii) 0.01	0.4369	0.7106	0.3501	0.4027	0.1948	0.2316	0.4238	3.3532	0.2448	0.0263	0.2790	0.2421	1.0186	3.3821
LSD (sii – sjj) 0.05	0.4054	0.6617	0.3259	0.3736	0.1808	0.2146	0.3934	3.1236	0.2265	0.0258	0.2603	0.2245	0.9498	3.1494
LSD (sii – sjj) 0.01	0.5369	0.7666	0.4317	0.4948	0.2395	0.2843	0.5211	4.1375	0.3027	0.0342	0.3448	0.2974	1.2581	4.1717
LSD (sij – sik) 0.05	0.4848	0.7908	0.3875	0.4471	0.2166	0.2563	0.4709	3.7336	0.2722	0.0298	0.3080	0.2702	1.1346	3.7634
LSD (sij – sik) 0.01	0.6422	1.0475	0.5132	0.5922	0.2869	0.3395	0.6238	4.9455	0.3606	0.0395	0.4106	0.3580	1.5029	4.9850

*, ** Significant at 0.05 and 0.01 probability levels respectively.

these parental cultivars which involved in these superior crosses were found to be good combiners for grains per main culm spike. Fourteen hybrid combinations showed significant estimates of SCA effects for grain weight per main culm spike, only five crosses of these fourteen crosses showed highly significant useful heterosis i.e. Sakha 206 X Gemmieza 7, Giza 164 X Sids 7, and Gemmieza 7 with each of Giza 170, Sids 1 and Gemmieza 3. Only two wheat cultivars from the seven wheat cultivars involved in these superior five crosses were detected to be good combiners for grain weight per main culm spike. As for spike length, sixteen hybrid combinations exhibited highly significant SCA effects, six of them showed useful heterosis. Eleven of the thirty six hybrid combinations studied showed highly significant SCA effects for grain weight per spike, Only three of these superior eleven crosses were previously found to show useful heterosis i.e. Sakha 206 X Sids 1, Giza 168 X Sids 1 and Sids 1 X Gemmieza 7. It is of interest to mention that the four wheat cultivar involved in these superior three crosses were found to be among the poorest general combiners for grain weight per spike. As for grain weight per plant, sixteen hybrid combinations showed highly significant estimates of SCA effects, only three of these superior sixteen crosses showed useful heterotic effects i.e. Giza 168 X Sids 1, Sids 1 X Gemmieza 7 and Gemmieza 3 X Gemmieza 7. The parental cultivar Sids 1 was found to be the only parent which considered to be good general combiner for grain weight per plant in these three crosses. Concerning 1000-grain weight, twelve crosses exhibited highly significant SCA effects, five of these superior crosses were previously found to show useful heterosis i.e. Sakha 206 with both of Gemmieza 3 and Gemmieza 7 and Giza 164 with each of Sids 1, Sids 7 and Gemmieza 3. Only three of the five parental cultivars involved in these five superior crosses i.e. Gemmieza 3, Sids 1 and Sids 7 found to be good general combiners for 1000-grain weight. So, the results obtained here concerning both general and specific combining ability effects could indicate that the excellent hybrid combinations were obtained from crossing good general combiner by good general combiner, good by low and low by low general combiners. Consequently, it could be concluded that general combining ability effects of the parental cultivars generally unrelated to the specific combining ability estimates of their respective crosses. The same conclusion was also drawn by Seleem (1993).

REFERENCES

Afiah, S. A. N.; S. A. M. Khattab and A. M. Abd El-Aziz (2000). F_2 diallel cross analysis of wheat (*Triticum aestivum* L.) under normal and saline environments: Proc. 9th Conf. Agron., Minufiya Univ., Sept., 2000: 35-47.

Al-Gazar, A. A. (1999). Diallel cross analysis of some bread wheat varieties. M.Sc. Thesis, Minufiya Univ., Egypt.

Al-Kaddoussi, A. R. and E. E. Hassan (1991). Heterosis in relation to general and specific combining ability in durum wheat (*Triticum turgidium* var. durum). Zagazig J. Agric. Res., 18 (1): 1-9.

Bayoumi, T. Y. (2004). Diallel cross analysis for bread wheat under stress and normal irrigation treatments. Zagazig J. Agric. Res., 31 (2): 435-455.

Comber, R. M. (2001). Estimation of the different components of genetic variance of some quantitative traits in bread wheat. Ph.D. Thesis, Faculty of Agric., Minufiya Univ., Egypt.

Darwish, I. H. and H. A. Ashoush (2003). Heterosis, gene effect, heritability and genetic advance in bread wheat. Minufiya J. Agric. Res., 28 (2): 433-444.

Dencic, S. and S. Borojevic (1992). Harvest index and spike index in crosses between wheat genotypes with different spike architecture. Plant breeding, 10 (9): 151-158.

El-Hennawy, M. A. (1995). Heterosis and combining ability in diallel crosses of eight bread wheat varieties. Al-Azhar, J. Agric. Res., 26 (12): 379 – 392.

El-Hosary, A. A.; M. E. Raid, Nagwa, R. A. and A. H. Manal (2000). Heterosis and combining ability in durum wheat. Proc. 9th Conf. Agron., Minufiya Univ., Sep. 2000, pp. 101-117.

El-Sayed, E. A. M. and M. Kh. Moshref (2005). Breeding for yield, yield components and some agronomic characters in bread wheat. Egypt, J. Agric. Res., 83 (2): 665-679.

El-Sayed, R. M. A. (1997). Quantitative inheritance of yield and some of its contributory characters in common wheat. M.Sc. Thesis, Faculty of Agric., Minufiya Univ., Egypt.

El-Seidy, E. H. and A. A. Hamada (2000). Interaction of wheat genotypes x water sources. Proc. 9th Conf. Agron., Minufiya Univ. Sept. 2000, pp. 17-34.

Esmail, R. M. and S. A. M. Kattab (2002). Genetic behaviour of yield and its components in three bread wheat crosses. Minufiya J. Agric. Res., 27 (2): 215-224.

Griffing, J. B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Australian J. Biol. Sci., 9: 463-493.

Hamada, A. A. (2003). Heterosis and gene action of yield and its components and some growth traits in an eight parents diallel cross of bread wheat under three sowing dates. Minufiya J. Agric. Res., 28 (3): 787-819.

Hassan, E. E. and A. M. Abd El-Monieum (1991). Combining ability, heterosis and gene action of some quantitative characters in wheat. Zagazig J. Res., 18 (5): 1369-1381.

Hendawy, F. A. (1994 a). General and specific combining ability estimates in a diallel cross of seven bread wheat varieties. Minufiya J. Agric. Res., 19 (1): 75-93.

Hendawy, F. A. (1994 b). Influence of location on heterosis and combining ability in bread wheat (*Triticum aestivum* L.). Minufiya J. Agric. Res., 19 (1): 2201-2224.

Hendawy, F. A. (1994 c). Combining ability for grain yield and its contributory characters in bread wheat (*Triticum aestivum* L.). Minufiya J. Agric. Res., 19 (1): 2315-2338.

Hendawy, H. I. (1990). Breeding for yield and its components in wheat. M.Sc. Thesis, Faculty of Agric., Minufiya Univ., Egypt.

Hendawy, H. I. (1998). Combining ability and genetics of specific characters in certain diallel wheat crosses. Ph.D. Thesis, Faculty of Agric. Minufiya Univ., Egypt.

Hendawy, H. I. (2003). Genetic architecture of yield and its components and some other agronomic traits in bread wheat. Minufiya J. Agric. Res., 28 (1): 71-86.

Hewezi, T. A. (1996). Graphical analysis of diallel cross of some bread wheat varieties. M.Sc. Thesis, Faculty of Agric. Minufiya Univ., Egypt.

Joshi, S. K.; S. N. Sharma; D. L. Singhania and R. S. Sain (2004). Combining ability in the F_1 and F_2 generation of diallel cross in hexaploid wheat (*Triticum aestivum* L.em.Thell). Hereditas 141: 115-121.

Moussa, A. M. (2005). General and specific combining ability and its interactions with two nitrogen fertilizer levels for yield and yield components in bread wheat. Minufiya J. Agric. Res., 30 (2): 579-618.

Saad, F. F. (1999). Heterosis parameters and combining ability for crosses among Egyptian and Austrian durum wheat entries. Assiut J. of Agric. Sci., 30 (1): 31-42.

Seleem, S. A. (1993). Heterosis and combining ability in common wheat. M.Sc. Thesis. Minufiya Univ., Egypt.

Seleem, S. A. (2001). Breeding studies of some characters in common wheat. Ph.D. Thesis, Minufiya Univ., Egypt.

Seleem, S. A. (2006). Combining ability and type of gene action in common wheat. Minufiya J. Agric. Res., 31 (2): 399-420.

Wilson, J. A. (1968). Problems in hybrid wheat breeding. Euphytica, 17: 13-33.

Wynne, J. C.; D. A. Emery and P. W. Rice (1970). Combining ability estimates in Archis hypogea. II. Field performance of F_1 hybrids. Crop Sci., 10: 713-715.

Zaied, H. M. M. (1995). Combining ability diallel cross of wheat. Ph.D. Thesis, Faculty of Agric., El-Minia Univ., Egypt.

قوة الهجين و تحليل القدرة على التآلف لبعض الصفات الكمية في قمح الخبز

حسان عبد الجيد دوام ، فتحي أحمد هنداوي ، منى محمد سراج الدين

قسم المحاصيل – كلية الزراعة – جامعة المنوفية

الملخص العربى

أجري هذا البحث في مزرعة كلية الزراعة بشبين الكوم جامعة المنوفية بهدف دراسة كل من: قوة الهجين و أهمية كل من القدرتين العامة و الخاصة على الائتلاف. و لتحقيق هذه الأهداف الثلاثة تم استخدام تسعة أصناف من القمح العادي و تم عمل جميع الهجن الممكنة بينها في موسم ٢٠٠٣/٢٠٠٤ و تم تقييم هذه الأصناف التسعة و جميع الهجن الناتجة منها في موسم ٢٠٠٥/٢٠٠٦ و ذلك في تصميم قطاعات كاملة العشوائية في ثلاثة مكررات و قد تم تحليل البيانات باستخدام طريقة جرفنج (١٩٥٦) لتقدير المكونات الوراثية للهجن التبادلية و تم دراسة كل من الصفات التالية :تاريخ طرد السنابل – طول النبات – عدد الفروع الجانبية على النبات – عدد الفروع المنتجة على النبات – طول سنبلة الساق الرئيسية – عدد السنيبلات في سنبلة الساق الرئيسية – وزن سنبلة الساق الرئيسية – عدد الحبوب في سنبلة الساق الرئيسية – وزن الحبوب في سنبلة الساق الرئيسية – كثافة سنبلة الساق الرئيسية – طول السنبلة – وزن حبوب السنبلة – محصول النبات الفردي – وزن الألف حبة و يمكن تلخيص النتائج المتحصل عليها كما يلي :

أظهرت النتائج وجود قوة هجين معنوية و مرغوبة لصفة محصول الحبوب و ذلك في ١٥ هجين و قد تراوحت من ١٣,٢٦% إلى ٩٧,٤٥% و ذلك مقارنة بمحصول أفضل الأبوين المشتركين في الهجين و قد وجد أن أفضل الهجن التي أعطت قوة هجين هو الهجين سخا ٢٠٦ x جميزة ٧ . كانت قيم التباين الراجعة إلى التراكيب الوراثية و الآباء و الهجن عالية المعنوية لجميع الصفات المدروسة ماعدا صفة كثافة سنبلة الساق الرئيسية. كانت قيم التباين الراجعة إلى متوسط قوة الهجين عالية المعنوية لجميع الصفات المدروسة فيما عدا صفة عدد

الفروع المنتجة على النبات ووزن سنبلة الساق الرئيسية و محصول الحبوب في النبات الفردي. كانت قيم التباين الوراثي الراجعة للقدرتين العامة و الخاصة على التآلف عالية المعنوية لجميع الصفات المدروسة مما يوضح أهمية كل من الفعل الجيني المضيف و غير المضيف في وراثة هذه الصفات . أظهرت النسبة بين تبايني كل من القدرتين العامة و الخاصة على التآلف أن التباين الوراثي المضيف و أيضا الفعل الوراثي المضيف x المضيف هو الأكثر أهمية في وراثة جميع الصفات المدروسة ماعدا صفة عدد الفروع و عدد الفروع المنتجة على النبات و محصول الحبوب للنبات حيث كان التباين الوراثي غير المضيف هو الأكثر أهمية في هذه وراثة هذه الصفات الثلاث. اظهر صنف القمح سدس ٧ مقدرة عامة عالية على التآلف و ذلك لصفة محصول الحبوب و كذلك اثنتا عشرة صفة أخرى هي ميعاد طرد السنابل و عدد الفروع و عدد الفروع المنتجة على النبات و طول سنبلة الساق الرئيسية و عدد السنيبلات في سنبلة الساق الرئيسية ووزن سنبلة الساق الرئيسية و عدد الحبوب في سنبلة الساق الرئيسية ووزن حبوب السنبلة الرئيسية و طول السنبلة ووزن حبوب السنبلة ووزن الألف حبة و محصول النبات الفردي من الحبوب. تم الحصول على أفضل التأثيرات المرغوبة للقدرة الخاصة على الائتلاف لصفة محصول الحبوب في ثلاثة هجن هي جيزة ١٦٨ x سدس ١ ، سدس ١ x جميزة ٧ وجميزة ٣ x جميزة ٧.