HETEROSIS AND COMBINING ABILITY ANALYSIS FOR YIELD AND ITS COMPONENTS IN DURUM WHEAT(*TRITICUM DURUM,* DESF.).

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ABSTRACT

Analysis of variance for combining ability in 6-parent diallel (excluding reciprocals) of durum wheat (*Triticum durum,* Desf.) revealed the following results. Desirable heterosis values over better parent were observed for some cross combinations for all the studied traits; plant height, days to heading, days to maturity, No. spikes / plant, No. kernels / spike, 1000 kernel weight and grain yield / plant. The analysis of variance for combining ability showed that mean squares due to general combining ability (GCA) as well as specific combining ability (SCA) were highly significant for all studied traits indicating the importance of both additive and non-additive gene effects with the preponderance of non-additive type of gene effects for yield and most of its components.

Key Words: Heterosis, General combining ability and Specific combining ability.

INTRODUCTION

Wheat today occupies a very great position among cereals in Egypt. Recent breakthrough in wheat production is not sufficient to meet the rapidly growing population of the country which is estimated to cross one hundred million by the next couple of decades. This necessities the acceleration of improvement in this crop. For this, combining ability studies are frequently used by plant breeders to evaluate newly developed cultivars for their parental usefulness and to assess the gene action involved in various characters, so as to design an efficient breeding plan for further genetic upgrading of the existing material (Menon Uma Ans Sharma (1994).

Heterosis in the F_1 progeny has been used as an indicator of genetic diversity between parents. Magnitude and direction of heterosis for mid- and better parent are very important in the exploitation of heterosis. Hence, the present study was conducted to estimate the heterosis values for both mid and better parent, general (GCA) and specific(SCA) combining ability and correlation coefficient between all pairs of the studied traits.

MATERIALS AND METHODS

Six varieties and/or liens of durum wheat (*Triticum durum,* Desf.) namely Bani-suief 3 (P_1), Brachoua /3/ win / kif ‘s’ // Ruff’s’/Fg ‘s’ (P_2), Kucuk (P_3), SRN1/Laru /3/Yav1 /FGO//Rch/4/Lican (P_4), ZEGZAG/ ALTAR84 // Dipper2 (P_5) and Zeina-3 (P_6).

The present study was carried out at Sids Agricultural Research Station during the two successive seasons 2001/2002 and 2002/2003. In the first season, the parents were crossed in all possible combinations excluding reciprocals using hand emasculation and pollination to produce the hybrid seeds of 15 F_1’s .In the second season, the resulting 15 F_1's along with the six parents were grown in a randomized complete block design with three replications. Each of the parents and their F_1's were represented by two rows 10 cm between seeds and 30 cm between rows with 3 meter long. All recommended agronomic practices were applied. Twenty competitive plants were selected randomly for recording observations on plant height (PLH), days to heading (DHE), days to maturity (DMA), number of spikes/plant (S/P), number of kernels/spike (K/S), 1000 kernel weight (KW) and grain yield/plant (GY/P).

Collected data were subjected to the usual analysis followed for a randomized complete block design proposed by Snedecor and Cochran, 1980 using computer soft ware MSTATC program. Heterosis was computed according to Bhatt (1973). The combining ability analysis was done according to Method II, Model 1 of Griffing (1956).

RESULTS AND DISCUSSION

Mean performance :

Significant differences were observed among the parental genotypes as well as their F_1's for all studied traits. The variation due to parents vs. crosses were highly significant for all studied traits. (Table 1).

Among the parental genotypes, P_5 possessed the highest values of days to heading, days to maturity ,number of spikes/plant and grain yield/plant, whereas it was the shortest parent for plant height .On the other hand, P_1 gave the lowest values of days to heading, days to maturity, 1000 –kernels weight and grain yield/plant. The P_3, P_6, and P_2 gave the highest value of plant height, number of kernels /spike and 1000- kernels weight, respectively.

With respect to F_1's, data obtained indicated that the cross combination P_1 x P_2 was the tallest cross while P_1 x P_4 showed the lowest plant height. For days to heading P_1 x P_3 was the earliest in spike emergence, while the P_4x P_5 was the latest in spike emergence (Table1).

Concerning days to maturity the cross P_1 x P_3 was the earliest for days to maturity, while P_4 x P_5 was the latest. With regard to number of spikes/ plant the crosses P_1 x P_4 and P_2 x P_6 gave the height values while the cross P_5 x P_6 gave lowest value. For kernels/spike cross P_3 x P_5 showed the highest value, while the cross p_2x p_6 produced the lowest value. Cross combination P_2 x P_3 produced the heaviest 1000- kernels weight, while the cross P_4 x P_6 produced the lightest 1000- kernels weight. For grain yield, it was observed that the cross P_3 x P_5 produced the highest grain yield/plant, whereas, the cross P_3 x P_4 gave the lowest value.

Heterosis effect :

Desirable heterosis values over better parent were observed for plant height in the crosses P_1 x P_2, P_2 x P_4, P_2 x P_5 and P_4 x P_6. For days to heading (negative direction) in the crosses P_1 x P_3, P_1 x P_4 and P_1 x P_6 showed heterosis relative to mid-parent. For number of spikes/plant, most of the crosses under study possessed highly significant heterosis over better parent. For number of kernels/spike, only five crosses showed significant heterosis over better parent (P_2 x P_3, P_3 x P_4, P_3 x P_5, P_3 x P_6 and P_5 x P_6), For 1000-kernel weight, highly significant heterosis over better parent were observed in four crosses (P_1 x P_3, P_1 x P_5, P_1 x P_6, P_3 x p_5 and P_3 x P_6). For grain yield per plant, most of the crosses showed heterosis values over better parent (Table 2).

Table (1): Mean performance of the studied six parents and their F_1's for plant height (PLH), days to heading (DHE), days to maturity (DMA), number of spikes/plant (S/P), number of kernels/spike (K/S), 1000-kernel weight (KW) and grain yield /plant(GY/P).

PARENTS	PLH	DHE	DMA	S/P	K/S	KW	GY/P
P_1	102.33	109.33	156.00	15.0	75.00	51.40	37.70
P_2	105.00	105.00	153.00	13.00	60.33	64.65	43.22
P_3	106.33	106.00	155.33	11.67	61.00	54.55	51.00
P_4	104.67	107.67	156.33	15.67	67.33	54.16	43.07
P_5	93.43	103.00	155.33	15.67	75.67	55.31	61.67
P_6	105.67	106.67	155.33	12.67	69.33	54.50	42.44
crosses							
P_1 X P_2	109.33	107.67	156.33	13.00	73.00	64.21	38.43
P_1 X P_3	104.00	104.67	155.33	17.00	72.67	61.31	59.77
P_1 X P_4	97.67	106.00	157.00	18.33	73.00	54.98	53.08
P_1 X P_5	100.33	108.67	156.33	17.33	66.33	60.30	56.33
P_1 X P_6	102.67	106.00	159.00	17.00	75.33	58.41	31.19
P_2 X P_3	104.67	105.67	159.67	11.67	64.67	67.74	43.12
P_2 X P_4	108.00	108.67	158.00	15.67	64.00	62.56	62.53
P_2 X P_5	108.00	107.33	157.33	17.33	60.33	66.05	57.72
P_2 X P_6	106.67	109.00	157.67	18.33	59.33	60.63	72.71
P_3 X P_4	105.33	106.00	158.33	17.00	70.00	52.59	30.26
P_3 X P_5	102.00	107.33	158.67	14.67	81.00	59.95	74.00
P_3 X P_6	100.33	107.67	157.67	13.33	73.33	58.81	40.54
P_4 X P_5	102.57	110.00	160.00	13.00	73.00	58.05	42.21
P_4 X P_6	108.00	106.67	159.33	17.33	68.33	43.59	46.42
P_5 X P_6	103.00	107.33	159.67	11.33	80.00	55.53	40.58
LSD .05	3.025	2.489	3.164	2.899	5.656	6.404	17.74
.01	4.040	3.327	4.229	3.875	7.561	8.559	23.35

Analysis of variance :

The analysis of variance for combining ability showed that mean squares due to GCA as well as SCA were highly significant for all studied traits, indicating the important role of both additive and non additive variances in the inheritance of the studied traits. GCA/SCA values were more than unity in plant height, number of kernels per spike and 1000-kernel weight indicating that the additive variance was more important than the dominance ones in inheritance of these traits. (Table 3).

Grain yield/plant had the higher GCA variance (125.68) followed by number of kernels/spike (82.07). Number of kernels per spike had the greatest GCA/SCA (4.74) followed by number of kernels/spike (3.01). The present obtained results were in harmony with those obtained by Verma and Luthra (1983), Afiah (1999), Yadav and Nasinghani (2000), Ashoush *et al*, (2001), Mahmoud (2002) and Salgotra *et al*, (2002).

General combining ability effects :

The estimates of general combining effects are presented in Table (4). P_2 was found to be good combiner for plant height (2.528), P1 and P_5 were seemed to be good combiners for number of kernels per spike (2.833 and 3.042, respectively), P_2 was found to be good combiner for 1000-kenel weight (5.509) and P_2 and P_5 were good combiners for grain yield per plant.

Table (2): Heterosis (H) values % for mid-parent (MP) and bitter-parent (BP) for all characters studied of F1 diallel.

Crosses	H	PLH	DHE	DMA	S/P	K/S	KW	GY/P
P_1 X P_2	MP	5.466**	0.467	1.187	-7.140**	7.880**	10.660**	-5.010
	BP	4.124**	2.543*	2.176	-13.330**	-2.670	-0.681	-11.100
P_1 X P_3	MP	-0.316	-2.790*	-0.214	27.500**	6.863**	15.730**	34.770**
	BP	-2.191	-0014	-0.429	13.330**	-3.107**	12.391	17.200**
P_1 X P_4	MP	-5.630**	-2.300*	0.534	19.570**	2.576	4.168	31.438**
	BP	-6.68**	-1.551	1.075	16.980**	-2.667	1.514	24.845**
P_1 X P_5	MP	2.503	2.355*	-0.422	13.04**	-11.95**	13.013**	13.385
	BP	-1.954	5.505**	-0.212	10.590**	-12.340**	9.022**	-8.654
P_1 X P_6	MP	-1.282	-1.851	2.141	22.89**	4.388	10.305**	-22.150**
	BP	-2.839	-0.628	2.363	8.557**	0.440	7.174*	-26.500**
P_2 X P_3	MP	-0.946	0.158	3.568*	-5.410**	6.593**	13.658**	-8.472
	BP	-1.561	0.638	4.359**	-10.230**	6.016*	4.780	15.451
P_2 X P_4	MP	3.020*	2.194	2.155	9.300**	0.261	5.308	44.940**
	BP	2.857	3.495**	3.268*	0.000	-4.946	-3.233	45.200**
P_2 X P_5	MP	9.190**	3.205**	2.050	20.930**	-11.280**	10.119**	10.048
	BP	3.170*	4.204**	1.288	10.590**	-20.270**	2.166	-6.410
P_2 X P_6	MP	1.266	2.998**	2.270	42.860**	-8.480**	1.762	69.750**
	BP	0.946	3.810	3.052	41.000**	-14.420**	-6.218	68.250**
P_3 X P_4	MP	-0.158	-0.780	1.604	24.930**	9.091**	-3.250	-35.660**
	BP	-0.941	0.000	3.219*	8.488**	3.966**	-3.593	-40.660**
P_3 X P_5	MP	2.119	2.711	2.146	7.317**	18.540**	9.133**	31.360**
	BP	-4.070**	4.204**	2.150	-6.382*	7.044**	8.389*	19.990*
P_3 X P_6	MP	-5.350**	1.254	1.502	9.589**	12.53**	7.868**	-13.240
	BP	-5.640**	1.575	1.506	5.209*	5.770*	7.809*	-20.520*
P_4 X P_5	MP	3.550**	4.430**	2.150	-17.020**	2.098	6.053*	-19.390*
	BP	-2.010	6.796**	2.150	-17.040**	-3.528	4.954	-31.550**
P_4 X P_6	MP	2.694*	-0.467	2.246	22.350**	0.000	-19.770**	8.584
	BP	2.205	0.000	2.575	10.590**	-1.442	-20.020**	7.328
P_5 X P_6	MP	3.466*	2.385*	2.790*	-20.000**	10.350**	1.141	-22.050**
	BP	-2.527	4.204**	2.790	-27.690**	5.720*	0.398	-34.200**
LSD 0.05	MP	2.619	2.156	2.740	2.511	4.899	5.546	15.131
	BP	3.025	2.461	3.164	5.197	5.656	6.404	17.472
LSD 0.01	MP	3.501	2.882	4.968	3.356	6.548	7.413	20.225
	BP	4.043	3.290	4.229	6.946	7.561	8.559	23.353

* Significant at P> 0.05. ** Significant at P> 0.01.

Table (3): Observed mean squares from ordinary and combining ability analysis in $_{F1's}$ diallel.

S.O.V	DF	PLH	DHE	DMA	S/P	K/S	KW	GY/P
Genotypes	20	43.18**	8.56**	10.14**	16.18**	122.9**	94.95**	456.9**
Parents	5	70.15**	14.32**	4.09**	8.86**	130.62**	62.35**	220.13**
Crosses	14	35.11**	6.26**	5.83**	17.76**	124.57**	103.87**	563.42**
P vs. C	1	21.32	12.01	100.8	30.67	60.98	133.14	149.53
GCA	5	27.12**	1.48**	2.27**	4.88**	82.07**	77.52**	125.68**
SCA	15	10.15**	3.31**	3.75**	5.56**	27.26**	16.36**	161.18**
Error	40	3.36	2.28	3.68	3.09	11.76	15.08	112.22
GCA/SCA		2.67	0.45	0.61	0.88	3.01	4.74	0.78

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

Parents	PLH	DHE	DMA	S/P	K/S	KW	GY/P
P_1	-1.01**	0.361	-0.569	0.917**	2.833**	-0.552	-3.558
P_2	2.528**	-0.056	-0.694	-0.417	-5.71**	5.509**	2.287
P_3	0.278	-0.681*	-0.028	-1.042	-0.50	0.383	0.787
P_4	0.515	0.486	0.597	0.917**	-0.583	-3.29**	-2.753
P_5	-2.96**	-0.264	0.264	-0.042	3.042**	0.511	6.439**
P_6	0.653	0.153	0.431	-0.333	0.917	-2.56	-3.293
LSD gi 0.05	0.691	0.577	0.721	0.663	1.291	1.460	3.987
gi 0.01	0.923	0.759	0.964	0.886	1.725	1.952	5.330
gi-gj 0.05	1.069	0.881	1.119	1.241	1.999	2.264	6.177

Specific combining ability :

The estimates of SCA effects of all cross combinations are presented in (Table 5). The best cross combinations on the basis of SCA for plant height were P_1 x P_2 (3.994), P_2 x P_5 (4.940) and P_4 x P_6 (3.007). For days to heading, three cross combinations were good for SCA (negative direction toward earliness) P_1 x P_3, P_1 x P_4 and P_1 x P_6. None of the cross combinations seemed to be good on the basis of SCA effects for days to maturity (negative direction toward earliness) P_1 x P_3, P_1 x P_4 and P_1 x P_5. Four cross combinations gave good values for SCA in comparing to the cross for number of spikes per plant, P_1 x P_3 (2.077), P_2 x P_5 (2.744), P_2 x P_6 (4.036) and P_3 x P_4 (2.077). For number of kernels per spike, three cross combinations were the best on the basis of SCA effect, P_1 x P_2 (6.208), P_3 x P_5 (8.792) and P_5 x P_6 (6.375).

None of crosses showed good SCA effects for 1000-kernel weight. For grain yield per plant, four cross combinations were very good for SCA effects, P_1 x P_3 (13.49), P_2 x P_4 (14.04), P_2 x P_6 (24.762) and P_3 x P_5 (17.73). These data were partially similar to those obtained by Verma and Luthra 1983, Hassan, (1997), El-Beially and El-Sayed, (2002).

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

CROSSES	PLH	DHE	DMA	S/P	K/S	KW	GY/P
P_1 X P_2	3.994**	0.393	0.375	-2.55**	6.21**	1.196	-9.24
P_1 X P_3	0.911	-1.982*	-1.292	2.077*	0.667	3.416	13.49*
P_1 X P_4	-5.66**	-1.815*	-0.250	1.452	1.083	0.764	10.43
P_1 X P_5	0.482	1.601*	-0.583	1.411	-9.21**	2.281	5.00
P_1 X P_6	-0.798	-1.482*	1.917	1.369	1.917	3.456	-10.9
P_2 X P_3	-1.964*	-0.565	.176**	-.1923*	1.208	3.687	-8.99
P_2 X P_4	1.132*	1.268	0.875	0.119	0.625	2.283	14.04*
P_2 X P_5	4.940*	0.685	0.542	2.744**	-6.67**	1.973	0.03
P_2 X P_6	-0.339	1.935*	0.780	4.036**	-5.54**	-0.386	24.762**
P_3 X P_4	0.715	-.774	0.542	2.077*	1.417	-2564	-16.81
P_3 X P_5	0.557	1.310	1.280	0.702	8.792**	0.993	17.730**
P_3 X P_6	-4.42**	1.226	0.042	-0.339	3.250	2.927	-6.00
P_4 X P_5	1.186	2.810**	1.917	-2.92**	0.875	2.771	-10.4
P_4 X P_6	3.007**	-0.940	1.083	1.702	-1.767	-8.624**	3.51
P_5 X P_6	1.482	0.476	1.750	-3.34**	6.375**	-.0481	-11.52
LSD							
Sij 0.05	1.897	1.559	1.984	1.818	3.545	4.013	10.95
0.01	2.535	2.084	2.651	2.430	4.739	5.365	14.63
Sij-sik 0.05	2.830	2.329	2.959	2.713	5.290	5.989	16.34
0.01	3.783	3.113	3.956	3.626	7.071	8.006	21.84
Sij-ski 0.05	2.620	2.155	2.757	2.511	4.899	5.545	15.13
0.01	3.502	2.881	3.356	3.356	6.548	7.412	20.22

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تحليل قوة الهجين والقدرة على الائتلاف للمحصول ومكوناته فى قمح المكرونة

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أجريت هذه التجربة بمحطة البحوث الزراعية بسدس موسم ٢٠٠٢/٢٠٠١ و٢٠٠٣/٢٠٠٢ لدراسة قوة الهجين والقدرة على الائتلاف في تحليل تبادلي لبعض الهجن الناتجة من تزاوج ٦ آباء من قمح المكرونة حيث اظهر تحليل التباين قيما مرغوبة لقوة الهجين على مستوى الأب الأحسن فى بعض الهجن للصفات تحت الدراسة وهى طول النبات وتاريخ طرد السنابل وتاريخ النضج وعدد السنابل فى النبات وعدد الحبوب فى السنبلة ووزن الألف حبة ومحصول النبات الواحد. كما اظهر تحليل التباين للقدرة العامة على الائتلاف وجود معنوية عالية بالنسبة للتباين فى كلا من القدرة العامة على الائتلاف والقدرة الخاصة على الائتلاف مما يؤكد وجود تأثير واضح للجزء المضاف وغير المضاف من التباين الوراثى مع زيادة تأثير الأخير على المحصول وبعض مكوناته.