HETEROSIS AND COMBINING ABILITY FOR GRAIN YIELD COMPONENTS OF SOME DURUM WHEAT CROSSES

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Abstract

Ahalf diallel crosses among five durum wheat genotypes were investigated for plant height, grain yield and its components. The study showed equal importance of both GCA and SCA for all characters, except plant height and kernel weight. Plant height showed more importance for SCA (dominance gene action) as kernel weight was mainly under the control of additive type (higher GCA). Sohag 3 was the best combiner for grain yield/plant and its components number of spikes /plant and kernel weight, being followed by Banisewef I due to good general effects of number of kemels /spike and kernel weight. The third one was Banisewef 3. Four crosses showed the highest mean performance and SCA effects and heterosis in grain yield /plant and at least one or two of yield components . These crosses were(P_1xP_4), (p_3xp_5), (p_3xp_4) and (P_2XP_3) with heterosis estimates of 89, 26, 1 6 and 8 °/O, respectively. Heterosis in grain yield and its components were related mainly to over dominance.Plant height, generally, showed positive over dominance toward tallness. Grain yield / plant and its components showed different types of dominance, being in different directions and averaging negative partial dominance for number of spikes/plant and number of kemels/spike, being positive fon kernel weight, while grain yield/plant averaged overdominance for increased yield.

INTRODUCTION

Durum wheat (*Triticum turgidum* var. durum) is a world wide important crop with a total area of approximating 10 million hectares and total production of 25 million metric tons. It is consumed in the form of pasta (28 %), Couscous (16 %), bread making and other uses (24 %). Durum is popularly known as "Daker" and has been grown in Egypt for a long time until the early decades of 20th century. However, durum area in Egypt is about 40000 hectares (100,000 Feddan), all being in Upper Egypt especially at El-Mennia and Baniswef governorates. However, The productivity of Durum wheat is about 7 ton / ha (20 Ardab/Fed.) as compared with 6.5 ton / ha (18 ardab/Fed.) for bread wheat.

The success of any breeding program for any crop depends on a better understanding of the genetic background of yield and its components, as well as the presence of sufficient genetic variation among available genotypes to permit effective selection. For instance, determination of type of gene action is very useful for selecting the most

efficient breeding method. One of such methods is to perform the diallel cross analysis given by Griffing (1956).

Bhuller *et al.* (1982), stated that dominance components are predominant for grain yield and spikes/plant, while additive components were more important for number of grains / spike and number of kernel weight. Also Verma *et al.* (1984) found significant dominance and additive effects for number of grain/spike, kernel weight and plant height. Mann and Sharma (1995) detected significant differences for general combining ability (GCA) among that parent, and for specific combining ability (SCA) in the crosses for all yield attributes revealing that additive and dominance gene effect were important in the inheritance of the studied characters. Similarly, Hendawy (1998) found highly significant GCA and SCA effects for plant height, number of grains/spike, kemel weight and grain yield/plant. The respective GCA / SCA exceeded significantly the unity, indicating the predominance of additive type of gene action for these characters. On the other hand, he detected useful heterotic effects on grain yield / plant for eight out of fifteen crosses ranging from 62.9 to 81.3 % over the better parents . Moreover, positive heterosis effects for taller plant, higher number of spikes / plant, increased number of kernels / spike, heavier kemel weight and higher grain and straw yield were detected by Mahrous (1998) and Abd El-Wahed (2001) and Abd El-Noor (2005).

Using diallel cross analysis, Mahrous (1998) found significant GCA and SCA variances for grain yield/plant and its componenfs. However, GCA/ SCA ratios exceeded the unity reflecting the important role of additive genetic effects in controlling yield -related traits. In addition, Mohamed (1999), Tammam and Abd El-Gawad (1999), Ghanem (2001), and Mostafa (2002) observed highly significant general and specific combining ability for number of spikes / plant, number of kemels / spike, kemels weight and grain yield/plant. On the other hand, the importance of non-additive gene action expressed by the significant specific combining ability effects for all traits was also reported by Abdel - Hameed (2002).

The main objective of this investigation was to study the types of gene action controlling some of the economic traits in five parental diallel crosss of durum wheat.

MATERIALS AND METHODS

This investigation was conducted at El Giza Agriculture Research Station, during the two successive seasons 2001/2002 and 2002/2003.

Four durum wheat cultivars in addition to a promising line representing a wide range of genetic variability were selected for this study . The names and pedigrees of these genotypes are presented in Table (1).

Table 1. Names and Pedigrees of five parents varieties of durum wheat

NO	Parental Material	Pedigree	Source
P_1	PLATA-13 /AKAK1-4//AJAIA-2	CD 559281198 -D- IM-OY-OM-OY-IB-OY	ICARDA
P_2	Sohag 2	Cr"S"/Pelicamo//Cr"S"/G'S"Sh I9-ISh-OSH	EGYPT
P_3	Sohag 3	Mexi"S"/Mgha 51792//Durum 6	EGYPT
P_4	Banisewef 1	Jo"S"/AA "S"//Fg"S"	EGYPT
P_5	Banisewef 3	Corm"S"/Rufo"S"CD 48693-I0Y-IM-IY-OM	EGYPT

In 2001/2002 season, all possible crosses among the five parents were made. In the second season of 2002/2003, the five parents and ten hybrids were planted in a field experiment using the randomized complete block design (30 rows) with three replications. Each plot consisted of two 3m long rows for each genotype, with 20 cm between rows and 10 cm between plants. Data were recorded on random samples of 10 guarded plants from each row, for plant height, number of spikes / plant, number of kemels / spike, kemels weight (gm), grain yield / plant (gm). General and specific combining ability estimates were obtained by employing Griffing's (1956) diallel cross analysis, Method 2 Model 1 (fixed model). Better parents (BP) heterosis was estimated as the percentage deviation of Fl mean from the mean of the corresponding better parents. Degree of dominance expressed in potence ratio, was also estimated by using the methodof Smith (1952).

RESULTS AND DISCUSSION

Mean Performance

Mean Performance of the five parental genotypes and their F_1 hybrids for all studied characters were presented in Table (2). These crosses were observed to account for the highest average perforrnance of respective characters.

Among the parental genotypes, Sohag 3 gave the heaviest 100 Kernels weight (6. 1 5gm) and the highest grain yield / plant (56.02 gm), while the cultivar Sohag 2 had the tallest plants (92.66cm).

Moreover, F_1data indicated that the cross (P_2XP_5) followed by (P_2XP_3) showed the highest values for plant height (101.66 and 101.13cm). In addition, cross (P_3XP_5), llowed by cross (P_1xp_4) produced the highest numbers of spikes / plant, while the cross (P_1 xP_2) gave the lowest value. Meanwhile, for number of kernels/spike, crosses (P_1XP_3) and (p_1xp_5) gave the highest values, while the cross (p_1xp_2) produced the lowest value. Taking Kernel weight into consideration, Crosses (p_1xp_4) and (p_3xp_5) produced the heaviest kernels (5.59 and 5.49 gm, respectively), while cross (p_1xp_3) produced the lightest kernels (4.13gm).Concerning grain yield / plant, cross (p_1xp_4)

ranked the first and gave the highest value (84.38gm/plant) followed by cross (p_3Xp_5) which yielded (70.83gm/plant), while cross (p_2xp_5) gave the lowest value (42.65 gm/plant).

Table 2. Mean Performance of the five varieties and their ten F_1,s

Genotype	Plant height	# SP/ PL	# K / SP	100 KW	GY / PL
P_1 Line	91.30*	18.33	41.66	4.63	44.74
P_2 Sohag 2	92.66*	25.00*	42.66	5.26	45.87
P_3 Sohag 3	92.00*	24.33*	49.00	6.15	56.02*
P_4 Banisewef 1	87.66	19.66	58.66*	5.11	44.16
P_5 Banisewef 3	89.00	25.33*	53.33	4.20	51.53
P_1 X P_2	98.00*	17.66	45.00	4.81	44.16
P_1 X P_2	88.66	23.66	54.00*	4.13	48.70
P_1 X P_2	95.66	25.66*	51.66*	5.59*	84.38*
P_1 X P_2	97.66*	19.33	52.66*	4.46	51.91
P_1 X P_2	101.13	24.66*	47.00	5.29	60.45
P_1 X P_2	97.66*	20.66	51.00*	5.32	44.83
P_1 X P_2	101.66*	23.00	48.00	4.86	42.65
P_1 X P_2	100.33**	21.66	46.66	5.28*	65.24
P_1 X P_2	100.33**	26.66*	51.33*	5.49*	70.83
P_1 X P_2	96.33	21.33	45.66	5.03*	51.65
L.S.D. at 0.05	4.388	2.709	3.655	0.917	5.169

SP / PL=Number of spiks / plant, # K / SP= Number of kernels/ spike, 100 KW=100 kernel weight.
GY / PL = Grain yeild / plant

Potence ratios and dominance degree

Table (3) revealed overdominance toward shortness in one hybrid (P_1XP_3) and tallness in the other nine hybrids to average positive overdominance. On the other hand, yield and its components showed different types of dominance. However, the average values indicated negative partial dominance for number of spikes/ plant and number of kernels, positive partial dominance for kernels weight and positive overdominance for grain yield/plant.

Table 3. Potence ratio of the fifteen crosses

crosses	Dominance Degree				
	Plant height (cm)	# SP / PL	# K / SP	100 KW	GY / PL
P_1 X P_2	9.05	-1.20	5.68	-1.08	-2.02
P_1 X P_3	-8.54	0.78	2.36	-1.66	-0.30
P_1 X P_2	4.36	10.11	0.18	2.98	153.27
P_1 X P_4	6.36	-0.71	0.89	0.22	1.11
P_1 X P_5	8.47	0.03	0.37	-0.93	1.87
P_2 X P_3	5.00	-0.63	0.04	1.92	-0.22
P_2 X P_4	8.83	-13.15	0.02	0.24	-2.14
P_2 X P_5	8.33	-0.14	-1.48	-0.67	2.55
P_3 X P_5	6.55	3.66	0.07	-0.33	7.57
P_4X P_5	4.00	-0.41	-13.00	-0.81	1.03
Average	7.00	-0.24	-0.49	0.54	6.25

SP / PL=Number of spikes / plant . # K / SP =Number of kernels / spike ,100 KW= 10 kernel weight.

GY / PL = Grain yield / plant

Heterosis Effect

As illustrated in Table (4) nine of the ten hybrids showed significantly positive heterosis in plant height reflecting the positively over dominance (toward tallness). For yield components, only the hybrids showed over dominance and hence, had significant heterosis, are P_1xP_4 (31 %) and P_3XP_5 (5%) for increased number of spikes / plant, P_1XP_2 (5 %) and P_1X P_3 (10 %) for increased number of kernels / spikes and P_1XP_4 (9%) and P_2XP_4 (1%) for heavier kernels weight. Furthermore, two of them, P_1XP_4 and P_3XP_5 revealed considerable heterosis in grain yield (89 and 26 %). However heterosis for grain yield was accompanied by heterosis in at least one of yield components. On the other hand, the two hybrids P_2XP_3 and P_3XP_4 showed heterosis estimates of (8 and 16 %, respectively), reflecting the presence of overdominance for higher grain yield / plant although they didn't show heterosis in any of their yield components (Table 4). However, Walton (1971) stated that a parent superior for one yield component should be crossed with parent superior for the other components to obtain heterosis in a complex character such as grain yield. These results are in harmony with those reported by Mahrous (1998) and Abd El-Wahed (2001) and Abd El-Nour (2005).

Table 4. Percentage of Heterosis over better (B.P) for all trials recorded in the Durum hybrid

Genotype	Plant height	# SP / PL	# K / SP	100 KW	GY / PL
	B.P	B.P	B.P	B.P	B.P
P_1 X P_2	-5.78	-29.36	5.49	-8.55	-3.73
P_1 X P_3	3.630	-2.75	10.20	-32.86	-13.07
P_1 X P_2	4.78	30.51	-11.93	9.39	88.60
P_1 X P_4	6.97	-23.69	-1.26	-3.67	0.74
P_1 X P_5	9.14	-1.36	-4.08	-4.23	7.91
P_2 X P_3	5.39	-17.36	-13.06	1.27	-2.27
P_2 X P_4	9.71	-9.19	-9.99	-7.76	-17.23
P_2 X P_5	9.05	-10.97	-20.46	-14.09	16.45
P_3 X P_5	9.05	5.25	-3.75	-10.67	26.43
P_4X P_5	8.23	-15.79	-22.16	-1.70	0.23
P_1 X P_2	4.39	2.71	3.66	9.17	5.17

SP / PL=Number of spikes / plant . # K / SP =Number of kernels / spike ,100 KW= 10 kernel weight.

GY / PL = Grain yield / plant

Combining Ability

1- Analysis of Variance

Highly significant differences among mean squares due to both general and specific combining ability effects for the parental genotypes and F_1s were detected (Table 5). Both GCA and SCA values were significant and nearly of equal importance for all studied characters. On the other hand, GCA / SCA ratio indicated that kernel weight was controlled by additive type of gene action, while plant height and grain yield were controlled mainly by dominant genes, due to increased SCA. The obtained results were in harmony with those obtained by Mohamed (l999), and Mostafa (2002).

2- General/ Combining Ability

Table (6) presented the estimates of general combining ability effects for each parent. The results indicated that the cultivar (P_1) showed significant negative general combining ability for all studied characters. Meanwhile, the cultivar Sohag 2 (P_2) proved to be a good combiner for plant height, and number of spikes / plant. In addition, Sohag 3 (P_3) was the best combiner for grain yield / plant, number of spikes / plant and heavy kernel weight. Moreover, cultivar Banisewef 1 (P_4) had good general combining ability for grain yield / plant, number of kernels / spike and kernel weight. The cultivar Banisewef 3 (P_5) might possess valuable general combining ability for increased number of kernels / spike, and increased number of spikes / plant . These results reflected the average performance of the respective characters.

3- Specifi Combining Ability Effects:

Specific combining ability effects for the studied characters of the ten F_1 crosses are given in Table (7). All hybrids showed very highly significant specific effects, for tallness, (except for P_1xP_3) Likewise, for number of spikes / plant, significant positive specific combining abilities were recorded in crosses wp4, p3Xp5 so, for number of kernels / spike, significant specific combining ability effects were detected in crosses, P_1xP_3, P_1xP_5 and P_2xP_4. In addition, the crosses P_1xP_4, P_2xP_3, P_3xP_5 were considered to be promising hybrids for grain yield improvement as they showed high specific combining ability. These crosses could account for the highest average performance of the respective characters, (Table 7).

Table 5. Mean square analysis of for traits studied in durum wheat crosses

Parents	d.f.	Plant height	# SP / PL	# K / SP	100 KW	GY / PL
Genotype 14	14	69.1984**	24.7524**	60.8032**	82.4823*	422.3384**
G. C. A	4	30.7392**	35.1095*	83.2952**	132.8915**	30932820**
S. C. A	10	84.5821**	20.6095**	51.8063**	62.3188*	467.8689**
Error	28	6.8879	2.6238	4.7794	31.0052	9.5558
G.C.A/S.C. A		0.3630	1.7030	1.6070	2.1320	0.6610

SP / PL=Number of spikes / plant . # K / SP =Number of kernels / spike ,100 KW= 10 kermel weight.
GY / PL = Grain yield / plant

Table 6. Estimates of general combining ability effects

Parents	Plant height	# SP / PL	# K / SP	100 KW	GY / PL
P_1 (line)	-1.354	-1.686	-1.010	-2.506	-0.629
P_2 Sh_2	1.698	0.171	-2.771	0.606	-5.598
P_3 Sh_3	0.360	1.505	0.181	3.020	4.890
P_4 Bs_1	-0.969	-0.876	2.371	1.553	1.557
P_5 Bs_3	0.265	0.886	1.229	2.613	-0.420
SE GI	0.262	0.100	0.182	1.181	0.364
SE GI-GJ	0.656	0.250	0.455	2.953	0.910

SP / PL=Number of spikes / plant . # K / SP =Number of kernels / spike ,100 KW= 10 kermel weight.
GY / PL = Grain yield / plant

Table 7. Estimates of general combining ability effects

Parents		Plant height	# SP / PL	# K / SP	100 KW	GY / PL
P_1 X P_2		2.298*	-3.286	-0.503	-0.578	-3.454
P_1 X P_3		-5.697*	1.381	5.540	-9.792	-9.402
P_1 X P_4		2.632**	5.762**	1.016	6.341	29.417**
P_1 X P_5		3.398**	-2.333	3.159**	2.241	0.882
P_2 X P_3		3.917**	0.524	-0.302	-1.363	7.324**
P_2 X P_4		1.613*	-1.095	2.111**	0.470	-5.163
P_2 X P_5		4.346**	-0.524	0.254	-0.300	-5.173
P_3 X P_4		5.584**	-1.429	-5.175	2.780	4.759*
P_3 X P_5		4.315**	1.810*	0.635	3.889	12.519**
P_4X P_5		1.679*	-1.143	-7.222	0.722	-3.528
L.S.D.	(Sij)	1.093	0.666	1.214	6.965	2.427
At	(Sij-sik)	3.936	1.499	2.731	10.448	5.460
0.05	(Sij-ski)	3.280	1.249	2.276	9.538	4.550

SP / PL=Number of spikes / plant . # K / SP =Number of kernels / spike ,100 KW= 10 kermel weight.
GY / PL = Grain yield / plant

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قوة الهجن والقدرة على الائتلاف لمكونات المحصول فى بعض هجن القمح الديورم

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أجرى هذا البحث لتقييم الهجن الدائرية لخمسة تراكيب وراثية لقمح الديورم (أربعة من الأصناف التجارية وصنف مستورد) خلال الموسم ٢٠٠٢/٢٠٠١ والموسم ٢٠٠٣/٢٠٠٢ فى المزرعة البحثية لمركز البحوث الزراعية بالجيزة لتقدير قوة الهجين ودرجة السيادة والقدرة العامة والخاصة على الائتلاف.

يمكن تلخيص النتائج كما يلى : أظهرت التراكيب الوراثية المختلفة فروقا معنوية فى متوسطات الصفات المدروسة حيث أعطى الصنف سوهاج ٣ أعلى قيم لمتوسطات وزن حبوب ومحصول الحبوب للنبات الواحد بينما أعطى الصنف بنى سويف ٣ أعلى قيم لعدد السنابل /نبات والصنف بنى سويف ١ أعلى قيم لعدد الحبوب فى السنبلة.

أظهرت النتائج أيضا وجود قوة هجين بالنسبة لبعض الهجن لكل من عدد السنابل وعدد الحبوب ووزن الحبوب ومحصول النبات.

بالنسبة للقدرة العامة على الائتلاف أظهر الصنف سوهاج ٣ قدرة عالية على الائتلاف بالنسبة لمحصول الحبوب لكل نبات بجانب عدد السنابل ووزن الحبوب كما أظهر الصنف بنى سويف ١ قدرة عالية على الائتلاف بالنسبة لعدد الحبوب فى السنبلة ووزن الحبوب ومحصول النبات.

أظهرت الدراسة أيضا وجود سيادة فائقة وموجبة بالنسبة لصفة محصول الحبوب لكل نبات وسيادة جزئية سالبة لعدد السنابل وعدد الحبوب وسيادة جزئية موجبة لوزن الحبوب.

أظهرت تأثيرات القدرة الخاصة على الائتلاف أنماتماثلت مع النتائج المتحصل عليها من قوة الهجين وذلك بالنسبة لبعض الهجن لكل من عدد السنابل وعدد الحبوب ووزن الحبوب ومحصول النبات