GENETIC DIVERGANCE AND GENETIC BEHAVIOUR IN SOME BREAD WHEAT CROSSES.

MENSHAWY A.M.M.,S.A. EL-SAWI AND M.A. KHALED
National Wheat Research Program, Field Crops Research Institute, ARC.

ABSTRACT

The present study was conducted at Sakha Agric. Res. Stn. during 2001/2002 and 2002/2003 seasons. Six bread wheat cultivars namely; Sids 1, Gemmeiza 9, Sakha 61, Sakha 93, Giza 163 and Giza 165 were crossed in a half diallel crosses mating design to study genetic diversity and genetic behaviour for earliness, plant height and yield characters. In addition, the relationship between genetic diversity and hybrid performances, SCA effects and heterosis were also determined. Genetic diversity was measured on quantitative morphological traits on the basis of Euclidean distance. The results reflected the presence of dissimilarities between these parents for studied characters. The six parents distributed in three different clusters: I, II and III each was composed of two parents. Euclidean distances ranged from 8.7, between Sakha 61 and Sakha 93 to 36.8 between Sakha 61 and Giza 163.The maximum genetic distance between clusters was detected between cluster I and either of cluster II or cluster III. Mean Square of both GCA and SCA were significant for all studied characters except for SCA for days to maturity and kernels/ spike. GCA was more important than SCA except for 100-kernel weight which had equal values. The two cultivars Sakha 61 and Gemmeiza 9 were the better combiners for days to heading and Sakha 61 only for days to maturity. Moreover, Gemmeiza 9 was the best combiner for number of spikes per plant, number of kernels per spike and grain yield. No statistically significant association was observed between genetic diversity with F_1 performance, SCA effects and heterosis for all studied characters. Heterosis for days to heading and to maturity was directed towards early heading and maturity. Crosses between parents categorized as unrelated by Euclidean distance based on quantitative traits, expressed greater heterosis for crosses between unrelated parents than crosses between related parents. In general, the highest values of heterosis from mid parents were obtained for the crosses between unrelated parents. This indicated that, heterosis may

be due in part to genetic distance, other factors are involved in the expression of heterosis in bread wheat.

Key words: ***genetic, wheat, genetic diversity, cluster analysis, similarity, Euclidean distance, GCA and SCA, heterosis and quantitative traits.***

INTRODUCTION

Wheat is the most important grain crop in Egypt as a source of human food. Increasing production per unit area appears to be one of the important factors for narrowing the wheat production gap. In this respect , plant breeder needs continuous knowledge about nature of gene action and genetic systems controlling the inheritance of wheat traits. Parental selection is the first step in any plant breeding program. Theoretical and empirical results indicate that the probability of recovering a superior progeny genotypes is greater if both parents are similar in performance as opposed to one parent being inferior for one or more traits (Martin *et al.*, 1995). Yet, genetic diversity between parents is necessary to drive transgressive segregants from the cross. These presents are dilemma because parents with similar performance frequently share the same genes. It is important to detect genetic diversity among phenotypically superior breeding materials so that appropriate crosses could be produced. Heterosis in the F_1 progeny has been used as an indicator of genetic diversity between parents. Assuming heterosis is a function of heterozygosity, heterosis should be on increasing function of parental diversity. Cowen and Frey (1987 a, b) were unable to predict yield heterosis in oat from diversity measures based on coefficient of parentage, Euclidean distance based on quantitative traits, or two distance measures based on information from diallel matings. In a wide array of winter wheat crosses, Cox and Murphy (1990) found that F_2 heterosis was positively related to Euclidean distance but not with coefficient of parentage. Martine *et al.*, (1995) found no association between heterosis and genetic diversity in a seven – parents diallel crosses of spring wheat. Moreover, the expression of heterosis was due in part to genetic diversity but was unpredictable and also depend on factors not elucidated by their study (Fabrizius *et al.*, 1998). The diallel analysis is considered as a method to study the genetics of complex traits and as a tool in plant breeding (Baker 1978). Heterosis values relative to mid- parents in wheat have been studied by many researchers (Afiah

1999, Salama 2000 and Hamada *et al.*, 2002) . Abd El-Aty 2002 showed significant additive types of gene action for days to heading, 100- kernel weight and grain yield, while, plant height, number of kernels per spike and number of spikes per plant, the dominance variance was larger in magnitude than the additive one. Shehab El-Din, 1997, Menshawy (2000 and 2004) and Menshawy and Najeeb (2004) found the additive effects were the major contributer in the genetic variance for days to heading and to maturity as well as plant height. However, it was associated with non additive genes regarding yield characters.

The main objective of this study was to detect the magnitude of genetic divergence between some old and new Egyptian cultivars and study the genetic behaviour of earliness, plant height and grain yield and its components in these genotypes.

MATERIALS AND METHODS

The present study was conducted during the two wheat-growing seasons 2001/2002 and 2002/2003, at Sakha Agricultural Research Station, Agricultural Research Center, Egypt. Six diverse bread wheat cultivars were selected and crossed in all possible combinations excluding reciprocals, in 2001/2002 season to produce their F_1 crosses. Name and pedigree of these cultivars are shown in Table 1.The six parents plus 15 F_1's were evaluated in a randomized complete block experiment with three replications during 2002/2003 wheat growing season. Each genotype was grown in a single row of 2m long, 30 cm apart and the plants were spaced 20 cm apart within the rows. The recommended package of cultural practices was followed. Data were recorded on five randomly selected plants per row in each of the three replications.

The studied characters were: number of days to heading (day), number of days to physiological maturity (day), plant height (cm), number of spikes per plant, number of kernels per spike, 100-kernel weight (g) and grain yield per plant (g). Data obtained were statistically analyzed on plot mean basis.

To study the parental clustering, means of the six parents for the studied characters were subjected to a multivariate analysis (Johnson and Wichern, 1988). Therefore, hierarchical clustering procedure using Ward's minimum variance method, which minimize within cluster sums method performing a disjoint cluster analysis on the basis of Euclidean distances as outlined by Anderberg (1973) and developed by Hair *et al.*, (1987). In the application of Ward's method, genetic divergence among wheat parents and clustering patterns are presented as dendrograms. The dendrogram is constructed on Euclidean distance basis. All these computations are performed using SPSS computer software (1995).

Table 1: Name and pedigree of the studied parental bread wheat cultivars.

Parent #	Name	Cross Name & Pedigree
1	Sids 1	HD 2172 / Pavon "S" // 1158.57/ Maya 74 "S" Sd 46-4Sd-2Sd-1Sd-0Sd
2	Gemmeiza 9	Ald "S" / Huac // Cmh 74A. 630 / Sx CGM 4583-5GM-1GM-0GM
3	Sakha 61	Inia / RL 4220 // 7c / Yr "S" CM15430 –2S-5S-0S-0S
4	Sakha 93	Sakha 92/ TR 810328 S 8871-1S-2S-1S-0S
5	Giza 163	T. Aestivum/ Bon // Cno / 7c CM33009 –F-15M-4Y-2M-1M-1M-1Y-0M
6	Giza 165	Cno / Mfd //Man "S" CM43339-C-1Y-1M-2Y-1M-2Y-0B

Analysis of variance was conducted to test the differences among various genotypes. Also, to partitioning the genotypes sum of squares to general combining ability (GCA) and specific combining ability (SCA) effects according to Method 2, Model 1 of the diallel cross analysis provided by Griffing (1956), using parents and F_1's and assuming a fixed model. Heterosis for each cross was computed as the deviation from the mid parent value. Simple correlations were computed between F_1 performance, heterosis and SCA effects with measure of genetic diversity.

RESULTS AND DISCUSSION

I- Genetic divergence:

The estimates of Euclidean distances corresponding to the 15 possible comparisons taking two parents at a time are given in Table 2. This Table shows that about 93 % of the values were significant, more than corresponding chi-square value at 0.05 for seven degrees of freedom. Euclidean distances were ranged from 8.7, between Sakha 61 and Sakha 93 to 36.8 between Sakha 61 and Giza 163. These results indicated that parental genotypes expected to exhibit similarly a broad spectrum of variablilities. This conclusion might reflect some sort of dissimilarities between these parents for studied characters.

Table 2: Euclidean distances among the wheat parental genotypes based on quantitative traits.

	P_1	P_2	P_3	P_4	P_5	P_6
Sids 1 (P1)	-	-	-	-	-	-
Gemmeiza 9 (P_2)	21.9	-	-	-	-	-
Sakha 61 (P_3)	34.0	29.0	-	-	-	-
Sakha 93 (P_4)	33.1	31.8	8.7	-	-	-
Giza 163 (P_5)	22.1	27.2	36.8	35.4	-	-
Giza 165 (P_6)	19.1	24.4	24.3	22.6	14.1	-

Cluster analysis using genetic diversity measures based on Euclidean distance grouped the six parents in three different clusters I, II and III as presented in Figure 1. These clusters were composed of two parents each. The parents Sakha 61 and Sakha 93 were clustered separately from the other four parents and grouped more closely than the others. The maximum genetic distance between clusters was detected between cluster I and either cluster II or cluster III. Distribution of wheat parental in clusters are given in Table 3. Cluster I included Sakha 61 and Sakha 93, cluster II contained Giza 163 and Giza 165 and cluster III composed of Gemmeiza 9 and Sids 1.

Table 3: Distribution of six wheat parental genotypes into clusters.

Cluster #	Number of genotypes in cluster	Representative genotype
I	2	Sakha61 and sakha93
II	2	Giza 163 and Giza 165
III	2	Gemmeiza 9 and Sids 1

In this respect, Martine *et al*., (1995) used genetic diversity of seven spring wheat parents and grouped them into three clusters. Reddy (2001) determined genetic diversity in 52 strain of hexaploid tritical including two wheat genotypes and found that genotypes were grouped into four clusters.

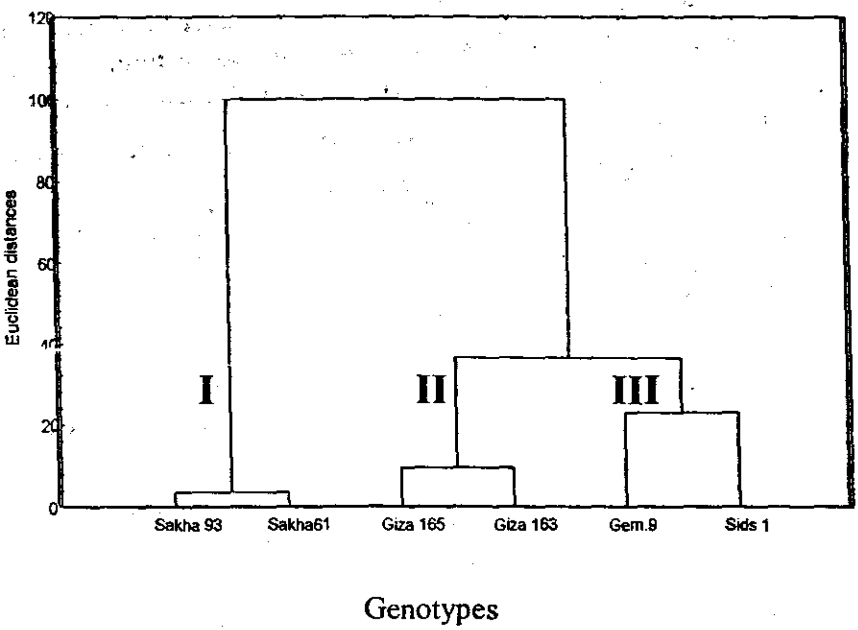

Figure 1:Denderogram presentation of six wheat genotypes.

II- Genetic behaviour:

The analysis of variance in Table 4 showed significant differences among genotypes for all studied characters indicating the existence of large amount of genetic variation which permitting further proceeding of the analysis and confirmed genetic diversity results.

Table 4: Analysis of variance of the studied characters in some bread wheat genotypes.

S.O.V.	df	MS						
		Days to heading (day)	Days to maturity (day)	Plant height (cm)	Spikes per plant	kernels per spike	100-kernel weight (g)	Grain yield/ plant (g)
Genotypes	20	51.94**	8.58**	243.91**	26.80**	100.17**	0.294**	140.84**
Error	40	2.71	2.40	7.21	4.30	31.93	0.060	19.36

** Significant at 0.01, probability level.

Mean square of both GCA and SCA were significant for all studied characters except, SCA for days to maturity and kernels/ spike. For the all studied characters, GCA was more important than SCA except for 100-kernel weight which had equal values as presented in Table 5. Therefore, these characters are mainly influenced by additive gene action in these crosses. However, non-additive gene action may play an important role in certain crosses. It is evident that the presence of large amount of additive effects suggested the potentiality of improvement for days to heading and yield and its components. Moreover, selection procedures based on accumulation of additive effect would be successful in improving these traits. Similar results were obtained by Menshawy (1996) , El-Seid and Hamada (2000), Abd El-Aty and katta (2002), Hamada *et al.*, (2002), Hammad (2003) and Menshawy and Najeeb (2004).

Table5: Mean squares of general combining ability (GCA) and specific combining ability (SCA) of a 6-parents wheat diallel cross for studied characters.

S.O.V.	df	MS						
		Days to heading (day)	Days to maturity (day)	Plant height (cm)	Spikes per plant	kernels per spike	100-kernel weight (g)	Grain yield/ plant (g)
GCA	5	62.65**	9.16**	308.25**	16.20**	78.65**	0.098**	55.78**
SCA	15	2.20*	0.76	5.66*	6.51**	18.30	0.098**	44.00**
Error	40	0.90	0.80	2.40	1.43	10.64	0.020	6.45

* and** = Significant at 0.05 and 0.01 respectively.

The parents Gemmeiza 9 and Sakha 61 displayed significant negative GCA effects for days to heading as presented in

Table 6. In addition Gemmeiza 9 showed significant positive GCA effects for, spikes per plant and kernels per spike. Crossing the parents with highest and negative GCA effects for days to heading and to maturity would provide the greatest possibility of producing superior progeny for these traits, while the other characters were vice versa. Therefore, the two cultivars Sakha 61 and Gemmeiza 9 were good combiners for days to heading and Sakha 61 only for days to maturity. Moreover, Gemmeiza 9 was the best combiner for number of spikes per plant, number of kernels per spike and grain yield.

Table 6: Estimates of general combining ability effects of a six spring wheat parents for the studied characters.

Genotypes	Characters						
	Days to heading (day)	Days to maturity (day)	Plant height (cm)	Spikes per plant	Kernels per spike	100-kernel weight (g)	Grain yield / plant (g)
Sids 1 (P_1)	1.26**	0.23	-0.25	0.30	-2.53*	-0.57**	-2.35**
Gemmeiza 9 (P_2)	-1.07**	0.07	-1.83**	1.47**	5.97**	-0.40**	0.46
Sakha 61 (P_3)	-0.66*	-0.43	0.50	-0.32	1.92	-0.28**	-3.88**
Sakha 93 (P_4)	0.43	0.57	-3.58**	-2.58**	-3.05**	-0.21**	-8.33**
Giza 163 (P_5)	2.01**	0.49	2.92**	-2.98**	-1.22	-0.08	-7.8**
Giza 165 (P_6)	0.93**	1.16**	-3.08**	-0.51	-5.80**	-0.34**	-6.68**
LSD gi 0.05	0.64	0.60	1.04	0.81	2.20	0.10	1.71
0.01	0.87	0.82	1.42	1.10	3.00	0.13	2.33
LSD gi-gj 0.05	0.99	0.93	1.62	1.25	3.40	0.15	2.65
0.01	1.35	1.27	2.21	1.70	4.64	0.20	3.61

* and** = Significant at 0.05 and 0.01 respectively

Table 7, shows the estimates of SCA effects for the studied characters in the 15 crosses. These effects were negative and significant for days to heading and to maturity in two and one crosses respectively. On the other hand; SCA effects were positive and significant in one cross for number of spikes per plant , and number of kernel per spike, two crosses for plant height, and 100 kernel weight and in three crosses for grain yield . These results indicated the presence of non-additive gene effects for these crosses. It is suggested that the above mentioned crosses could be useful in wheat breeding programs for improving these traits. These results are in agreement with results obtained by Hamada *et al.*, (2002) and Menshawy (2004).

It is worthily to note that the parents in all crosses which had significant SCA effects , could be grouped in the same cluster.

Table 7: Estimates of specific combining ability effects for the studied characters of F_1 diallel crosses.

Genotypes		Characters						
		Days to heading (day)	Days to maturity (day)	Plant height (cm)	Spikes per plant	Kernels per spike	100-kernel weight (g)	Grain yield / plant (g)
P_1xP_2		0.26	-0.35	-0.71	-0.92	1.34	0.25	-3.90
P_1xP_3		0.68	0.41	-1.71	-1.00	0.48	0.03	-2.58
P_1xP_4		0.30	0.57	2.25	0.64	3.79	0.16	0.08
P_1xP_5		-2.53**	-0.97	-1.00	-0.52	-3.51	0.14	-1.69
P_1xP_6		-1.24	-0.14	1.66	1.29	2.97	0.55**	12.77**
P_2xP_3		0.35	0.82	1.50	1.73	-9.19**	0.14	4.74*
P_2xP_4		0.97	0.99	0.13	-1.48	-2.31	0.18	-0.50
P_2xP_5		0.80	-0.89	-0.13	-1.91	-2.77	0.13	-0.30
P_2xP_6		-0.24	-0.72	2.88*	-0.33	1.00	0.10	-0.95
P_3xP_4		1.72	-0.60	0.79	-0.50	-1.73	-0.08	0.81
P_3xP_5		-2.78**	0.20	-2.46	-0.27	3.30	0.17	3.11
P_3xP_6		-0.82	-1.97*	0.88	0.75	3.31	0.31*	1.67
P_4xP_5		-0.82	0.03	0.50	7.92**	3.72	0.07	15.44**
P_4xP_6		-0.86	-0.14	3.50*	-1.43	2.64	0.08	0.83
P_5xP_6		1.30	0.66	-0.28	0.74	1.69	-0.35*	-0.97
LSD ij	0.05	1.76	1.65	2.87	2.21	6.03	0.26	4.70
	0.01	2.40	2.26	3.91	3.02	8.23	0.36	6.41
LSD sij-skl	0.05	2.43	2.28	3.96	3.06	8.34	0.36	6.49
	0.01	3.31	3.12	5.40	4.17	11.37	0.49	8.85

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

Mid-parent heterosis was detected in the over all means for studied characters as seen in Table 8. Heterosis for days to heading and to maturity was towards early heading and maturity in general. Percentage of mid-parent heterosis for individual crosses ranged from -3.85 to 1.87 for days to heading, from -1.83 to 0.76 for days to maturity, and from -3.68 to 6.11 for plant height. Moreover, for yield and its components, heterosis values ranged from, -10.75 to 66.46, from -16.81 to 10.93, from -2.52 to 20.46 and from -6.16 to 67.94 for spikes/plant, kernels / spike, 100-kernel weight and grain yield respectively . Three of 15 crosses showed significant or highly significant form mid – parent heterosis for days to heading, while all crosses did not show significant heterosis for days to maturity. In addition, for spikes/ plant, 100-kernel weight and grain yield most crosses were significant or highly significant from mid-parent heterosis as presented in Table 8. Also, plant height was significant taller or shorter than the mid-parent for four crosses only. Concerning the kernels/spike, four crosses were significant higher or lower than the mid-parent. These results are similar to those obtained by Abd El-Aty (2002) and Hamada *et al.*,(2002).

Table 8: Percentages of mid-parent heterosis for all studied characters of 15 F_1 diallel crosses of wheat.

Genotypes	Characters						
	Days to heading (day)	Days to maturity (day)	Plant height (cm)	Spikes per plant	Kernels per spike	100-kernel weight (g)	Grain yield / plant (g)
P_1xP_2	0.161	-0.322	0.348	-10.75**	-0.489	15.22**	-6.16*
P_1xP_3	-0.166	0.000	-1.504	-6.51**	1.085	9.29**	1.25
P_1xP_4	0.000	0.439	3.704*	9.68**	9.666*	12.11**	12.52**
P_1xP_5	-3.852**	-0.860	-1.961	4.85**	-2.234	9.71**	7.72*
P_1xP_6	-2.208*	-0.542	2.740	8.33**	10.276*	20.46**	38.15**
P_2xP_3	0.656	0.321	1.976	8.50**	-16.807**	9.28**	16.42**
P_2xP_4	1.812	0.762	2.724	-5.59**	-4.877	10.31**	8.93**
P_2xP_5	0.305	-0.747	-0.341	-7.54*	-6.480	7.43**	8.65**
P_2xP_6	-0.156	-0.860	4.659**	-5.39**	1.173	9.58**	5.36
P_3xP_4	1.874	-0.437	2.542	5.99**	-1.789	2.89**	19.74**
P_3xP_5	-3.774**	-0.214	-3.676*	9.73**	4.283	7.37**	25.29**
P_3xP_6	-1.449	-1.834	2.326	8.54**	7.838	12.89**	18.64**
P_4xP_5	-1.422	0.000	1.000	66.47**	8.839	4.81**	67.94**
P_4xP_6	-0.971	-0.329	6.107**	0.79	10.927*	7.62**	22.82**
P_5xP_6	-0.150	-0.108	-2.013	17.17**	7.653	-2.62**	17.16**
Mean	-0.623	-0.316	1.242	6.952	1.937	9.097	17.627
New LSD 0.05	2.117	2.3	3.342	2.889	8.871	0.363	6.129
0.01	2.757	3.034	4.405	3.783	12.028	0.478	8.027

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

In this study, crosses between parents categorized as unrelated by Euclidean distance based on quantitative traits, expressed greater heterosis than crosses between related parents. In general, the highest values of percentage mid parent heterosis were for crosses between unrelated parents. This consequence indicates that, the heterosis may be due in part to genetic distance, other factors are involved in the expression of heterosis in spring wheat.

Correlations between measures of genetic diversity with hybrid performance, SCA effects and heterosis are presented in Table 9. No statistically significant association was observed between genetic diversity with F_1 performance, SCA effects or heterosis for all studied characters. Genetic diversity was inversely related with F_1 performance, SCA effects and heterosis for days to heading and plant height characters. Meanwhile, the other characters had signs opposite of those days to heading and plant height. These results may in part be explained by the interrelationship among the three measures (F_1 performance, SCA effects and heterosis) for the studied traits. Genetic diversity showed little or no promise for predicting these three measures. Cox and Murphy (1990) had found coefficient of parentage to be of little value in predicting F_2 heterosis in winter wheat. In Oat, Cowen and Frey (1987 a) were not able to use coefficient of parentage to predict F_1 heterosis. Souza and Sorrells (1991) found poor agreement between F_1 performance and genetic diversity based on coefficient of parentage, but noted that this diversity measure was better than one based on discretely inherited biochemical and morphological traits. Moreover, Fabrizius *et al.*, (1998) reported that, the expression of heterosis was due in part to genetic diversity but was unpredictable and also depended on factors not elucidated by their study

Table9: Correlation of genetic diversity measures with F_1 performance , SCA effects and heterosis.

	F_1 perfomance	SCA effects	Heterosis
Days to heading (day)	-0.184	-0.399	-0.311
Days to maturity (day)	0.268	0.245	0.285
Plant height (cm)	-0.110	-0.256	-0.210
Spikes per plant	0.295	0.304	0.305
Kernels per spike	0.088	0.168	0.034
100- kernel weight (g)	0.177	0.200	0.086
Grain yield/plant (g)	0.131	0.233	0.253

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التباعد الوراثى والسلوك الوراثى فى بعض هجن قمح الخبز.

عبدالسلام محمود محمد منشاوى ، سيد عبده محمد الصاوى ومحمد عبد الكريم إسماعيل خالد

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

أجـرى البحـث بمحطـة سـخا خـلال موسـمى ٢٠٠١/٢٠٠٢ ، ٢٠٠٢/٢٠٠٣. هجنت ستة أصناف من قمح الخبز تهجينا دائريا مستبعداً الهجن العكسية لدراسة التباعد الوراثى والسلوك الوراثى لصفات التبكير ، طول النبات و الصفات المحصولية .كما قدرت العلاقة بين التباعد الـوراثى مـع متوسـط الهجن ، القدرة الخاصة للائتلاف وقوة الهجين. تم حساب التباعد الوراثى على أساس Euclidean distances مستخدما الصفات الكمية . أظهرت النتائج وجود نوعاً من عدم التشابه بين الآباء للصفات المدروسة . وزعت الستة آبـاء فـى ثلاث مجموعات مختلفة وكانت كل مجموعة مشتملة على أبوين . كان مدى الـ Euclidean distances تراوح بين ٨,٧ بين سخا ٦١ وسخا ٩٣ إلى ٣٦,٨ بين سخا ٦١ وجيزة ١٦٣. كان تباين القدرة العامة و الخاصة على التآلف معنويـاً لكل الصفات المدروسة ما عدا القدرة الخاصة على التآلف لصفتى عدد الأيـام حتى النضج وعدد حبوب السنبلة . القدرة العامة على التآلف كانت أكثر أهمية عن القدرة الخاصة ماعدا صفة وزن الـ١٠٠ حبة فكانت متساوية. كان الأبوين سخا ٦١ وجميزة ٩ أعلى قدرة على التآلف لصفة عدد الأيام حتى طرد السنابل بينما كان الصنف سحا ٦١ أعلى قدرة على التآلف بالنسبة لعدد الأيـام حتـى النضج أيضا ، فى حين كان الصنف جميزة ٩ أحسن قدرة على التآلف لصفات عدد السنابل / نبات ، عدد حبوب السنبلة ومحصول الحبوب للنبات . لم يوجـد ارتباط معنوى إحصائيا بين التباعد الوراثى مع متوسط الهجن ، القدرة الخاصة على التآلف وقوة الهجين . كانت قوة الهجين بالنسبة لصفتى عدد الأيام حتـى طرد السنابل وحتى النضج جهة التبكير فى الطرد والنضج فى الغالب . التهجين بين الآباء الغير متصلة فـى مجموعـة علـى أسـاس Euclidean distances أظهرت قوة هجين عالية عن الهجن التى بين آباء متصلة فى مجموعة واحـدة. عموما كانت أعلى القيم لقوة الهجين على أساس متوسط الآبـاء بـين الهجـن الناتجة من آباء غير متصلة فى مجموعة واحدة ، وذلك يـدل علـى أن قـوة الهجين ربما ترتبط جزئيا مع المسافة الو راثية ولكن هناك أيضا بعض العوامل التي اشتملت عليها فى التعبير عن قوة الهجين فى قمح الخبز.