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Estimates of Combining Ability for low Input in Some Wheat Crosses

El-Seidy, E.H.[1], E1-Refaey R.A.[1], Hamada A.A.[2], and Arab S.A.[2]
[1]Faculty of Agriculture, Agronomy Department, Tanta University, Egypt
[2]National Gene Bank and Genetic resources, Agronomy Department, Egypt

ABSTRACT

The experiment was carried out at the experimental farm of Gemmeiza Agricultural Research Station, Egypt during the two successive seasons, 2003/2004 and 2004/2005. Diallel crosses among eight bread wheat genotypes were used to establish the experimental materials for this investigation. The aim of the present investigation was to determinate the magnitude of both general and specific combining ability and their interactions under three nitrogen fertilizer levels for heading date, plant height, spike length, number of spikes per plant, number of kernels per spike,1000-kernel weight and grain yield per plant. The mean squares associated with general and specific combining abilitiy were highly significant for all studied traits under the three different nitrogen fertilizer levels and their combined data. Results also showed high GCA/SCA variance ratios, which exceeded the unity, suggesting that selection based on phenotype could be effective to improve and develop wheat genotypes concerning these characters under these conditions, where the additive genes were dominant. The mean squares of interaction between nitrogen levels and both general and specific combining ability were significant for all studied traits, except for plant height for general combining ability. Generally, the obtained results showed that CHAM-6 / Mayon"s", Gimmeza 9 and Gimmeza 10 wheat genotypes proved to be good combiners for improving grain yield under three nitrogen levels and Gemmeiza 10 for spike length and Sakha 94 for grain yield under low nitrogen level. Some crosses had significant desirable SCA effects for yield, yield components and earliness, and most of these crosses might be of prime important in breeding program for traditional breeding procedures under low nitrogen level for decreasing nitric compound pollution.

Keywords: Diallel crosses, general combining ability, specific combining ability, nitrogen level, genotypes.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important major cereal crop all over the world. Wheat breeding program played the major role in developing new high yielding varieties. Increasing wheat production as a national goal could be achieved through increasing the production per unit area. The variation of agronomic management practices such as nitrogen fertilizer, seeding rates, irrigation system, insect and pathogen resistance influenced on grain yield and yield components. In Egypt, the total cultivated area of wheat was about 3 million feddan (season 2004/05) with an average yield of about 18.16 ardab /feddan, which produce about 8.185 million ton. This amount was not enough; it needs about 3.8 million ton or more to cover all needs, which is to be imported from abroad.

Evaluation of the performance of genotype under different nitrogen levels as an environment is important factor in plant breeding. The differential response of genotypes when subjected to different nitrogen levels possess a major problem of relating phenotypic performance to genetic constitution and makes, it difficult to decide which genotype should be selected. It is important to fully understand the nature of genotype x nitrogen interaction to make testing and selection of genotypes more efficient.

Combining ability analysis is the most widely used biometrical tool for giving an indication of the relative magnitude of genetic variance. These also provide a guide line for selecting elite parents and desirable cross combinations to be used in formulation of a systematic breeding project for rapid improvement.

Combining ability in wheat has been reported by several investigators, among them Rajara and Maheshwari (1996); Salgotra *et al.* (1997); Mehta *et al.* (1998); El–Hosary *et al.* (2000); Pandey *et al.* (1999); and Soylu (2003).

The objective of the present study to estimate the magnitude of both general and specific combining ability and their interactions with nitrogen fertilizer levels.

MATERIALS AND METHODS

This experiment was carried out at the experimental farm of Gemmeiza Agricultural Research Station, Egypt during the two successive seasons, 2003/04 and 2004/05. Eight common wheat varieties were used to establish the experimental materials for this investigation. The aims of the present investigation were to study: both general and specific combining ability and their interactions with three nitrogen fertilizer levels for heading date, plant height, spike length, number of spikes per plant, number of kernels per spike, 1000-kernel weight and grain yield per plant.

The names and origin of these varieties and/or lines are presented in Table (1). These parents were chosen to represent a wide range of variability in most of the studied traits.

In 2003/04 season, grains from each of the parental varieties and /or pure lines were sown at various dates in order to overcome the differences in time of heading. During this season, all possible parental combinations, without reciprocals, were made among the eight parents giving twenty eight crosses.

* *Corresponding Author: Ramadan.elrefaey@yahoo.com*

Table (1): The names and pedigree parental varieties and or lines evaluated.

No.	Pedigree	Origin
1	CHAM-6 / MayoN"s"	CIMMYT
2	LAKTA-1	CIMMYT
3	MELLAL-1	ICARDA
4	NABEK- 4	ICARDA
5	Gimmeiza7 CMH 74A.630/SX//SERI 82/AGENT CGM 4611-2GM-3GM -1GM-OGM.	Egypt
6	Gimmeiza9= Ald"s"/Huac//CMH 74 A.630/SxCGM 4583 –5GM- 1GM - OGM	Egypt
7	Gimmeiza10MAYA74"S"/on//1160147/3/BB/GLL/4/CHAT"S"/5/CROW"S"CGM4611-2GM-1GM-0GM	Egypt
8	Sakha 94 opata /Rayon//Kauz CMBW 90Y3180-0TOPM-3Y-010M-10M-010Y-6M-0S	Egypt

In 2004/05 season, adjacent three experiments were conducted; each one was for one of the three nitrogen fertilizer levels i.e., 25, 50, and 75 kg N /fed. Each experiment included the eight parents and their twenty eight F_1 hybrids, which were sown in (RCBD) with three replicates. The experimental plot consisted of three rows, 3 meters long with 30 cm. between rows, plants within rows were 10 cm. a part allowing a total of 30 plants/row in order to minimize border effects. The middle row was sown by the cross, while the outer two rows were sown by the two parents, one row for each. Adjacent plots were spaced by 60 cm. At maturity, ten guarded plants were selected at random from each row for subsequent measurements as follows: heading date, plant height, spike length, number of spikes per plant, number of kernels per spike, 1000-kernel weight and grain yield per plant.

Statistical procedures

General and specific combining ability estimates were obtained by employing Griffing (1956) diallel cross analysis designated as method 2 model 1.

RESULTS AND DISCUSSION

Variation and interaction with nitrogen fertilizer levels

The analysis of variance of each nitrogen fertilizer levels together with the combined data for seven studied traits are presented in Tables (2 and 3).

Nitrogen fertilizer levels mean squares were found to be highly significant for all the studied traits under the three nitrogen fertilizer levels as well as the combined data, indicating overall differences between the three nitrogen fertilizer levels. Results in Tables (2 and 3) showed that all traits were significantly increased with increasing nitrogen levels up to 75 kg N/fed. This result might be attributed to the pronounced improvement of growth yield and some of its components. Also, the highest values of all characters were obtained by applying 75 kg N/fed.

Application of nitrogen at the highest level 75 kg N/fed increased significantly grain yield and yield components (Tables 2 and 3) compared with the other levels 25 or 50 kg N/fed. The increase of grain yield/plant with increasing N levels may be due to the increase in the metabolic process in wheat plants and this in turn stimulates their growth which may account for the superiority of yield components and grain yield.

Analysis of variance for yield and its components under three nitrogen fertilizer levels are presented in Tables (2 and 3). Mean squares of genotypes were highly significant for all traits at three nitrogen fertilizer levels as well as the combined analysis, which indicate true differences among these genotypes. The genotypes by nitrogen fertilizer level interactions were also highly significant for all the studied traits, indicating that performance of a genotype differs from fertilizer level to another. This was expected since most of the varieties and, therefore, their crosses were derived from different origins. The presence of significant differences between genotypes would indicate the presence of genotypic variation. This genotypic variation would insure the validity of the comparisons between the means of these genotypes.

The differences between each of the partitionied components of the genotypes namely parents, crosses and parents vs. crosses were highly significant relative to the seven studied characters under three nitrogen fertilizer levels as well as the combined data. This mean that genetic constitutions of the parents as well as their crosses are widely different and the parents had a wide range of genetic variability.

Mean squares due to interaction between parents and nitrogen levels were found to be significant for all traits, except for number of kernels per spike and 1000 – kernel weight. These findings indicated that the parental varieties and /or lines differed in their mean performance in most tested traits, it also revealed that parental lines varied in their response to nitrogen levels in most traits.

Interactions between crosses and nitrogen fertilizer levels were highly significant for all traits, indicating that these crosses behaved differently from nitrogen fertilizer level to another. The interaction of parents vs crosses with nitrogen fertilizer levels was found to be significant for heading date, plant height, spike length, number of spikes/plant and grain yield/plant .It could be concluded that the test of potential parents for the expression of heterosis would be necessarily conducted over a number of environmental conditions. Similar results were previously reported by Hassan and Saad (1996), EL-Sayed (1997) and Hamada (2003).

Mean performance

The mean performance of the eight genotypes as well as twenty eight crosses of wheat at three nitrogen levels and the combined data are presented in Tables (4 to 6). Gemmeiza 7 and Sakha 94 were the earliest varieties, while varieties; Gemmeiza 9, Gemmeiza10, NABEK-4 were the latest ones.

Table (2): Mean square estimates of ordinary analysis for heading date, plant height and spike length at three nitrogen levels as well as the combined data.

Source	df	df comb	Heading date				Plant height				Spike length			
			N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
Replication (Rep)	2		1.398*	0.528	0.843**		0.066	13.904	0.082		0.050	0.258	0.142	
Nitrogen		2				4565.61**				1790.734**				198.32**
Rep with Nitrogen		6				0.923				4.684				0.15
Genotypes	35	35	13.17**	38.495**	36.739**	71.876**	54.226**	60.626**	62.038**	163.236**	2.11**	2.51**	3.50**	6.89**
Parents	7	7	19.47**	35.429**	39.185 **	89.230**	54.038**	106.870**	78.675**	201.822**	2.63**	3.81**	4.093**	9.262**
Crosses	27	27	11.38**	30.430**	24.591**	50.825**	55.715**	45.449**	57.665**	152.164**	1.75**	1.90**	2.298**	4.869**
Par vs crosses	1	1	17.14**	277.714**	347.636**	518.77**	15.337**	146.714**	63.640**	192.100**	8.05**	9.78**	31.616**	44.758**
GenotypesxNitrogen		70				8.262**				6.827*				0.611**
Parents x Nitrogen		14				2.427*				18.881**				0.633**
Crosses x Nitrogen		54				7.790**				3.332				0.541*
P vs Crosses xNitrogen		2				54.023**				16.795**				2.345**
Error	70	210	0.341	2.709	0.385	1.145	0.389	9.708	0.878	3.658	0.27	0.24	0.219	0.081

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

Table (3): Mean square estimates of ordinary analysis for number of spikes/plant, number of kernels/spike, 1000-kernel weight and grain yield/plant at three nitrogen levels as well as the combined data.

Source	df	df comb	Number of spikes / plant				Number of kernels / spike				1000 kernel weight				Grain yield / plant			
			N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
Replication (Rep)	2		3.640*	2.581*	0.040		0.138	0.403	2.199		1.44	0.30	0.76		2.13	0.45	0.11	
Nitrogen		2				1283.4**				11582.8**				1609.2**				6052.2**
Rep with Nitrogen		6				2.087*				0.913				0.84				0.881
Genotypes	35	35	10.937**	8.652**	21.968**	31.949**	97.984**	111.7**	190.52**	354.408**	16.355**	20.324**	19.74**	52.87**	28.66**	40.56**	79.07**	88.34**
Parents	7	7	20.940**	20.133**	24.129**	59.957**	87.423**	89.142**	114.88**	281.7**	25.244**	23.315**	21.036**	22.65**	42.04**	44.60**	66.92**	92.68**
Crosses	27	27	8.014**	5.558**	19.615**	22.598**	102.99**	120.43**	212.10**	379.556**	14.343**	19.748**	19.16**	49.51**	25.52**	35.36**	84.74**	85.468**
Par vs crosses	1	1	19.856**	11.823**	70.370**	88.380**	36.810**	32.619**	137.49**	184.145**	8.456**	14.964**	26.08**	47.07**	19.91**	152.82**	11.12**	135.46**
GenotypesxNitrogen		70				4.804**				22.893**				1.77*				29.98**
Parents x Nitrogen		14				2.623**				4.864				1.47				30.45**
Crosses x Nitrogen		54				5.294**				27.994**				1.87**				30.07**
P vs Crosses xNitrogen		2				6.835**				11.386				1.22				24.20**
Error	70	210	0.974	0.549	1.478	1.0004	1.54	6.07	1.74	3.12	0.54	0.32	0.50	0.45	1.28	0.63	0.60	0.84

Table (4): Mean performances of eight wheat genotypes and their F_1 crosses for heading date and maturity date studied at three nitrogen levels as well as combined data.

Genotypes	Heading date day				Plant height, cm				Spike length , cm			
	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
CHAM-6 (P_1)	94.333	99.333	104.667	99.444	95.877	98.877	103.603	99.452	10.770	11.963	13.310	12.014
LAKTA-1 (P_2)	93.667	101.667	106.333	100.556	96.730	100.597	105.457	100.928	11.653	12.627	13.477	12.586
MELLAL-1 (P_3)	93.333	99.333	104.333	99.000	99.110	111.927	104.373	105.137	11.150	13.210	12.920	12.427
NABEK- 4 (P_4)	95.333	100.333	106.667	100.778	96.683	101.697	108.707	102.362	11.863	12.917	14.717	13.166
Gemmeiza7 (P_5)	89.333	92.333	98.333	93.333	108.537	114.203	116.980	113.240	13.587	15.170	16.150	14.969
Gemmeiza9 (P_6)	95.667	100.667	105.667	100.667	99.300	105.143	111.260	105.234	12.093	13.543	14.747	13.461
Gemmeiza10 (P_7)	95.667	101.333	106.000	101.000	97.917	100.897	103.753	100.856	12.000	11.883	12.790	12.224
Sakha94 (P_8)	89.667	94.333	97.667	93.889	103.133	110.850	114.087	109.357	10.633	11.790	13.277	11.900
P_1xP_2	95.333	103.333	109.333	102.667	90.233	96.563	101.627	96.141	12.073	13.603	15.737	13.804
P_1xP_3	93.333	105.333	110.667	103.111	92.787	98.047	104.077	98.303	11.850	13.170	14.060	13.027
P_1xP_4	99.333	105.333	109.333	104.667	97.673	102.717	103.790	101.393	13.060	13.637	14.667	13.788
P_1xP_5	91.000	95.333	100.333	95.556	96.427	101.493	107.353	101.758	11.970	14.053	15.973	13.999
P_1xP_6	96.333	104.333	109.333	103.333	94.883	98.177	101.143	98.068	10.927	12.717	14.653	12.766
P_1XP_7	95.333	104.667	109.333	103.111	101.093	103.810	107.637	104.180	11.907	12.823	14.310	13.013
P_1xP_8	92.667	99.000	105.667	99.111	101.460	103.713	107.953	104.376	11.733	12.677	13.867	12.759
P_2xP_3	94.000	101.333	104.667	100.000	97.887	100.533	106.773	101.731	11.983	13.163	14.807	13.318
P_2xP_4	95.333	101.000	106.667	101.000	100.110	102.633	107.367	103.370	12.780	13.943	14.827	13.850
P_2xP_5	92.667	99.333	104.667	98.889	107.833	110.767	116.740	111.780	11.967	12.653	14.833	13.151
P_2xP_6	93.333	101.000	107.667	100.667	102.663	104.880	109.853	105.799	11.787	12.817	14.193	12.932
P_2xP_7	95.333	103.000	107.667	102.000	95.690	99.607	105.460	100.252	12.903	13.060	14.720	13.561
P_2xP_8	91.333	95.667	104.333	97.111	102.403	106.243	110.107	106.251	12.413	12.977	14.907	13.432
P_3XP_4	93.667	102.000	112.333	102.667	96.947	100.110	104.523	100.527	12.563	14.120	15.997	14.227
P_3xP_5	92.667	99.000	104.333	98.667	103.380	105.260	110.397	106.346	11.870	13.320	15.447	13.546
P_3XP_6	95.333	101.667	107.667	101.556	104.057	107.983	110.853	107.631	11.193	12.420	13.797	12.470
P_3xP_7	96.333	103.667	109.667	103.222	90.923	95.270	96.617	94.270	13.107	14.723	15.817	14.549
P_3xP_8	95.333	102.667	107.667	101.889	99.043	102.770	106.600	102.804	10.650	12.693	15.067	12.803
P_4xP_5	92.333	102.333	105.667	100.111	97.217	100.420	103.490	100.376	12.730	13.733	15.620	14.028
P_4xP_6	97.333	104.667	109.667	103.889	96.250	100.093	103.100	99.814	12.997	13.923	14.737	13.886
P_4XP_7	95.667	106.333	110.333	104.111	98.737	105.320	109.557	104.538	12.000	13.663	14.837	13.500
P_4xP_8	95.667	103.333	108.667	102.556	101.837	105.193	109.733	105.588	13.000	14.837	16.647	14.828
P_5xP_6	93.333	102.333	108.333	101.333	98.680	102.040	104.563	101.761	13.637	14.367	16.730	14.911
P_5xP_7	92.333	107.000	111.333	103.556	90.993	96.497	97.860	95.117	13.577	14.873	15.477	14.642
P_5xP_8	93.333	107.333	112.333	104.333	102.033	106.103	109.847	105.994	12.933	14.723	16.823	14.827
P_6xP_7	95.333	108.333	112.667	105.444	98.577	104.013	107.117	103.236	12.527	12.963	15.047	13.512
P_6xP_8	91.667	99.333	106.000	99.000	101.630	107.923	110.120	106.558	13.147	14.873	16.033	14.684
P_7xP_8	95.667	102.000	108.333	102.000	103.677	107.987	112.813	108.159	13.233	14.600	16.667	14.833
Average	94.120	101.667	107.065	100.951	98.956	103.343	107.091	103.130	12.230	13.451	14.936	13.539
L.S.D 5%	0.954	2.688	1.014	1.747	1.019	5.088	1.530	3.123	0.853	0.804	0.764	0.808
L.S.D 1%	1.268	3.575	1.348	2.324	1.355	6.767	2.035	4.154	1.134	1.070	1.016	1.074
Reduction		-8.018	-13.75			-4.433	-8.221		18.117	9.942		
Reduction					7.596	3.500						

Table (5): Mean performances of eight wheat genotypes and their F_1 crosses for number of spikes/plant and number of kernels/spike at three nitrogen levels as well as combined data.

Genotypes	Number spikes / plant				Number of kernels / spike			
	N1	N2	N3	Comb	N1	N2	N3	Comb
CHAM-6 (P_1)	23.067	26.403	29.010	26.160	60.227	68.580	78.137	68.981
LAKTA-1 (P_2)	17.093	18.667	20.747	18.836	69.147	79.140	90.413	79.567
MELLAL-1 (P_3)	20.613	23.037	26.400	23.350	73.783	84.103	95.053	84.313
NABEK- 4 (P_4)	17.860	21.320	24.220	21.133	73.490	81.493	94.263	83.082
Gemmeiza7 (P_5)	16.837	22.870	26.203	21.970	77.163	84.793	96.157	86.038
Gemmeiza9 (P_6)	22.963	25.267	27.280	25.170	72.537	84.380	93.630	83.516
Gemmeiza10 (P_7)	20.960	24.527	28.140	24.542	76.433	84.793	95.463	85.563
Sakha94 (P_8)	22.617	25.877	29.390	25.961	69.327	80.543	86.310	78.727
P_1xP_2	22.450	25.523	27.517	25.163	62.517	76.580	86.250	75.116
P_1xP_3	21.877	26.197	30.240	26.104	75.093	84.023	94.140	84.419
P_1xP_4	23.043	25.717	31.397	26.719	61.003	66.817	76.807	68.209
P_1xP_5	21.660	26.197	30.040	25.966	82.627	90.623	100.353	91.201
P_1xP_6	21.737	24.523	30.173	25.478	68.477	78.707	95.853	81.012
P_1XP_7	20.810	24.863	28.980	24.884	61.270	68.413	77.643	69.109
P_1xP_8	22.673	25.553	29.697	25.974	65.380	74.487	82.233	74.033
P_2xP_3	19.763	22.973	25.247	22.661	74.500	82.010	93.093	83.201
P_2xP_4	18.547	20.883	28.317	22.582	70.723	79.850	91.200	80.591
P_2xP_5	21.667	24.647	29.870	25.394	80.423	93.170	100.803	91.466
P_2xP_6	21.197	25.177	31.843	26.072	70.138	81.360	92.790	81.429
P_2xP_7	19.930	23.543	28.300	23.924	68.613	74.300	81.367	74.760
P_2xP_8	23.203	24.453	31.590	26.416	75.237	86.677	101.377	87.763

Table (5) continue

P_3XP_4	20.330	22.087	23.680	22.032	74.913	85.857	99.217	86.662
P_3xP_5	22.140	25.063	30.203	25.802	77.680	84.437	95.540	85.886
P_3XP_6	21.163	24.033	29.133	24.777	76.190	83.040	89.413	82.881
P_3xP_7	22.103	25.647	30.467	26.072	80.070	91.187	107.340	92.866
P_3xP_8	21.980	23.350	27.617	24.316	70.450	85.407	96.323	84.060
P_4xP_5	17.483	22.637	27.083	22.401	68.440	76.613	88.770	77.941
P_4xP_6	22.707	23.750	30.137	25.531	79.313	83.583	98.410	87.102
P_4XP_7	18.867	21.863	22.397	21.042	76.393	84.157	96.413	85.654
P_4xP_8	21.137	22.987	24.453	22.859	77.063	85.800	97.257	86.707
P_5xP_6	23.703	24.810	28.343	25.619	69.597	81.787	87.063	79.482
P_5xP_7	21.923	23.670	27.280	24.291	80.735	90.367	106.490	92.531
P_5xP_8	17.537	24.683	26.240	22.820	72.150	80.363	101.300	84.604
P_6xP_7	21.627	24.500	28.767	24.964	72.303	88.287	109.153	89.914
P_6xP_8	23.220	25.663	31.270	26.718	74.217	84.137	95.270	84.541
P_7xP_8	21.437	25.173	23.950	23.520	76.177	82.370	87.113	81.887
Average	21.053	24.115	27.934	24.367	72.606	82.006	93.289	82.634
L.S.D 5%	1.611	1.210	1.985	1.633	2.024	4.022	2.156	2.882
L.S.D 1%	2.143	1.610	2.640	2.172	2.692	5.350	2.868	3.834
Reduction	24.633	13.672			22.171	12.095		

The crosses P_1 x P_5 (CHAM – 6 X Gemmeiza 7), P_2 X P_8 (LAKTA -1 X Sakha 94) were considered as the earliest crosses at 25, 50, 75 kg N /fed as well as combined data. The earliness of these parents and crosses could be attributed to the earliness of Gemmeiza 7 and Sakha 94, which may posses the genes controlling earliness. On the other hand, the crosses P_1 X P_4 (CHAM-6 x NABEK – 4) and P_6 XP_7 (Gemmeiza 9 X Gemmeiza 10) were considered as the latest crosses under these conditions.

All varieties and crosses differed in their mean performance in the studied traits and also varied in their response from one regime to another.

In general, all parents and their hybrids were affected by using 25 kg N /fed for all studied seven traits and the reduction for these traits ranged at 7.596 and 3.5 for plant height to 25.97 and 16.42 for grain yield/plant at 75 kg N/fed to 25 and 50 kg N/fed treatments, respectively. This reduction could be attributed to incomplete development of some grains per spike because the lack of nitrogen. This is attributed to their comparative results in yield component as indicated before. In fact, the superiority of CHAM-6/MayoN"s", Gemmeiza 9, Gemmeiza 10 and the crosses P_3xP_7,P_1xP_5 and P_4xP_6 in grain yield/plant is a result of their superiority in grain attributes i.e., number of spikes/plant, 1000-kernel weight and number of kernels/spike. Genotype differences in grain yield were reported by several investigators due to differences in yield attributes. Increasing nitrogen fertilizer levels led to increased cell elongation and cell division resulted in tall plants and increased the store assimilates and its translocation from sources to sink resulting in high and full grain filling, which might be effected to heavy weight. The present findings are in complete conformity with those reported by Reddi and Patil (2003), and Jitendra-Prasad and Sinha (2004).

Combining ability

The analysis of variance for combining ability at different nitrogen fertilizer levels for earliness, yield and yield components are presented in Tables (7 and 8). The mean squares associated with general and specific combining ability were highly significant for all studied traits under different nitrogen levels and their combined data. This would indicate the importance of both additive and non-additive gene effects which are involved in expression the performance of single cross progeny. Also, results showed that all other cases expressed high GCA/SCA variance ratios, which exceeded the unity, indicating that additive and additive by additive types of gene action were of greater importance in the inheritance of these studied characters under the three nitrogen fertilizer levels and their combined data. It is evident that the presence of large amount of additive effects suggests the potentiality of yield and yield components improvements, through selection procedures based on the accumulation of additive effects.

The mean squares of interaction between nitrogen levels and both general and specific combining ability were significant for all studied traits, except for plant height for general combining ability, indicating that the magnitude of additive and additive by additive types of gene action were variable from nitrogen level to another. The mean squares of SCA x nitrogen levels/SCA were much higher than GCA x nitrogen levels/GCA for all studied traits, indicated that non additive gene effects were much more influenced by the nitrogen fertilizer levels than additive gene effects in these traits. The genetic variance was previously reported by Khan *et al.* (1995), EL-Hosary *et al.* (2000), and Le-Gouis *et al*. (2002).

General combining ability effects

Estimates of general combining ability effects ($\hat{g}i$) for individual parental lines for each trait under three nitrogen levels as well as the combined data are given in Tables (9 and 10). High positive values of ($\hat{g}i$) would be of interest in five traits i.e. spike length, number of spikes/plant, number of kernels/spike, 1000-kernel weight and grain yield/plant, while, for heading date and plant height, high negative ($\hat{g}i$) values would be useful from the plant breeder point of view. The parental line

Table (6): Mean performances of eight wheat genotypes and their F_1 crosses for 1000 kernel weight and grain yield/plant at three nitrogen levels as well as combined data.

Genotypes	1000 kernel weight, gm				Grain yield / plant, gm			
	N1	N2	N3	Comb	N1	N2	N3	Comb
CHAM-6 (P_1)	36.761	39.134	44.107	40.001	41.217	50.220	60.497	50.644
LAKTA-1 (P_2)	34.670	37.917	42.743	38.443	35.677	40.237	51.227	42.380
MELLAL-1 (P_3)	36.983	40.710	43.153	40.282	38.353	44.293	56.477	46.374
NABEK- 4 (P_4)	38.847	42.490	45.607	42.314	37.690	39.773	58.233	45.232
Gemmeiza7 (P_5)	42.700	44.737	48.583	45.340	44.957	44.933	49.493	46.461
Gemmeiza9 (P_6)	38.123	43.050	46.747	42.640	45.353	48.537	59.163	51.018
Gemmeiza10 (P_7)	32.907	36.741	40.157	36.602	43.127	48.440	62.947	51.504
Sakha94 (P_8)	37.557	42.687	46.043	42.096	44.717	46.813	53.077	48.202
P_1xP_2	34.067	36.010	41.073	37.050	42.697	51.173	60.933	51.601
P_1xP_3	34.643	39.683	45.873	40.067	47.090	48.610	57.267	50.989
P_1xP_4	35.913	39.777	45.103	40.264	40.563	50.860	55.733	49.052
P_1xP_5	38.107	43.183	47.770	43.020	45.020	51.677	63.053	53.250
P_1xP_6	38.713	44.223	47.530	43.489	43.117	47.267	60.020	50.134
P_1XP_7	37.727	41.220	45.003	41.317	39.833	47.700	57.200	48.244
P_1xP_8	38.080	42.087	45.920	42.029	43.617	49.393	61.540	51.517
P_2xP_3	36.133	38.627	43.227	39.329	45.063	45.763	54.267	48.364
P_2xP_4	37.823	41.083	46.107	41.671	43.187	46.673	51.510	47.123
P_2xP_5	40.767	42.843	49.803	44.471	43.413	52.417	60.400	52.077
P_2xP_6	36.810	39.707	43.253	39.923	42.983	49.293	57.167	49.814
P_2xP_7	35.050	36.920	41.097	37.689	40.897	45.620	56.840	47.786
P_2xP_8	37.160	41.100	43.857	40.706	43.957	48.703	58.807	50.489
P_3XP_4	37.717	42.037	45.983	41.912	36.027	42.840	50.603	43.157
P_3xP_5	38.837	43.913	47.217	43.322	37.370	48.670	59.227	48.422
P_3XP_6	41.820	44.803	47.280	44.634	40.890	47.157	58.133	48.727
P_3xP_7	38.833	43.317	46.503	42.884	48.050	54.373	70.077	57.500
P_3xP_8	37.170	41.133	44.083	40.796	43.697	47.837	51.400	47.644
P_4xP_5	40.820	44.863	48.89	44.85	43.153	42.983	66.667	50.934
P_4xP_6	39.050	43.790	47.820	43.553	45.120	52.090	60.580	52.597
P_4XP_7	35.240	37.783	42.107	38.377	36.633	40.807	58.970	45.470
P_4xP_8	40.920	45.103	47.790	44.604	41.627	47.807	47.040	45.491
P_5xP_6	41.900	45.777	50.300	45.992	45.103	48.313	55.217	49.544
P_5xP_7	38.873	42.850	46.653	42.792	42.050	49.487	54.243	48.593
P_5xP_8	41.237	44.717	49.150	45.034	38.053	44.890	54.670	45.871
P_6xP_7	36.063	40.183	42.673	39.640	43.710	55.487	56.107	51.768
P_6xP_8	38.090	43.233	47.233	42.852	43.693	49.830	58.097	50.540
P_7xP_8	36.200	41.233	43.783	40.406	41.117	43.767	44.743	43.209
Average	37.842	41.630	45.265	41.579	42.189	47.631	56.990	48.937
L.S.D 5%	1.199	0.922	4.972	3.776	1.850	1.300	1.268	1.497
L.S.D 1%	1.595	1.226	6.613	3.991	2.460	1.730	1.687	1.991
Reduction	16.399	8.030			25.971	16.422		

CHAM-6 / MayoN"s" (P_1) expressed significant desirable (ĝi) effects for plant height, number of spikes per plant and grain yield per plant at 25, 50 ,75 N levels as well as the combined data. The parental line; LAKTA-1 (P_2) exhibited significant desirable (ĝi) for heading date at 25, 50, 75 N levels as well as the combined data, The parental line; MELLAL-1 (P_3) exhibited significant desirable (ĝi) for plant height at 25 and 75 kg N/fed and the combined data, while the significant positive desirable effects were found for number of kernels per spike at the three nitrogen levels as well as the combined data. The parental line NABEK- 4 (P_4) expressed significant positive (ĝi) effects for plant height, spike length and 1000 – kernel weight at the three nitrogen levels and the combined data, The parental line; Gimmeiza 7 (P_5) expressed significant desirable (ĝi) for heading date, spike length, number of kernels/spike and 1000 kernel weight at the three nitrogen levels and the combined data, while the significant positive effect for grain yield per plant at low nitrogen level (25 kg N/fed.) was detected. The parental line; Gimmeiza 9 (P_6) showed significant desirable (ĝi) for number of spikes per plant, 1000 - kernel weight and grain yield per plant at the three nitrogen levels and the combined data. Significant positive desirable (ĝi) were found for number of kernels per spike at 50, 75 kg N/fed nitrogen level as well as the combined data. The parental variety; Gimmeiza 9 (P_6) could be considered as an excellent parent in breeding programs towards releasing varieties characterized by higher grain yield and most of its components. The parental line; Gimmeiza 10 (P_7) expressed significant desirable (ĝi) for plant height and number of kernels per spike under the three nitrogen levels and the combined data and grain yield per plant at 50 and 75 kg N/fed nitrogen levels and the combined data. However, it could be considered as an excellent parent in breeding programs for spike length under low N levels. The parental line; Sakha 94 (P_8) expressed significant desirable (ĝi) for heading date, number of spikes per plant, 1000 - kernel weight and grain yield per plant under most conditions and the combined data. In most traits, the values of (ĝi)

Table (7): Mean square estimates of general and specific combining ability for heading date, plant height and spike length at three nitrogen levels as well as the combined data.

Source	df	df comb	Heading date				Plant height				Spike length			
			N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
GCA	7	7	13.234**	19.187**	17.434**	47.987**	22.377**	38.001**	37.448**	103.34**	1.442**	1.287**	1.949**	4.138**
SCA	28	28	2.177**	11.243**	10.950**	17.951**	14.500**	15.761**	16.487**	42.180**	0.518**	0.722**	0.969**	1.835**
GCA/ N		14				0.934**				2.242				0.270**
SCA/ N		56				3.209**				2.284**				0.187**
Error	70		0.114	0.903	0.128	0.382	0.130	3.236	0.293	1.220	0.091	0.081	0.073	0.082
GCA/SCA			6.079	1.706	1.592	2.673	1.543	2.411	2.271	2.450	2.783	1.782	2.011	2.255
GCA x N/GCA						0.019				0.022				0.065
SCA x N/SCA		210				0.179				0.054				0.102

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

Table (8): Mean square estimates of general and specific combining ability for number of spikes/plant, number of kernels/spike, 1000-kernel weight and grain yield/plant at three nitrogen levels as well as the combined data.

Source	df	df comb	Number of spikes / plant				Number of kernels / spike				1000 kernel weight				Grain yield / plant			
			N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
GCA	7	7	8.725**	9.353**	10.08**	25.80**	74.44**	81.54**	105.2**	255.5**	18.6**	24.77**	23.15**	64.56**	10.03**	20.30**	26.80**	39.22**
SCA	28	28	2.376**	1.267**	6.633**	6.862**	22.22**	26.15**	53.07**	83.78**	2.16**	2.275**	2.432*	5.889**	9.435**	11.83**	26.25**	27.00**
GCA/ N		14				1.179**				2.831**				0.980**				8.955**
SCA/ N		56				1.707**				8.831**				0.493**				10.25**
Error	70		0.325	0.183	0.493	0.333	0.512	2.022	0.581	1.386	0.180	0106	0.168	0.151	0.428	0.211	0.201	0.280
GCA/SCA			3.686	7.382	1.519	3.760	3.350	3.118	1.983	3.050	8.590	10.890	9.519	10.963	1.063	1.083	1.021	1.452
GCA x N/GCA						0.046				0.011				0.015				0.228
SCA x N/SCA		210				0.249				0.101				0.084				0.380

Table (9): Estimates of general combining ability effects for heading date, plant height and spike length at three nitrogen levels as well as the combined data.

Parents	Heading date				Plant height				Spike length			
	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
P_1	0.492**	0.100	-0.025	0.189**	-2.429**	-2.782**	-2.304**	-2.505**	-0.501**	-0.445**	-0.453**	-0.466**
P_2	-0.242*	-0.700**	-0.592*	-0.511**	-0.032	-0.767	0.502**	-0.099	-0.085	-0.359**	-0.344**	-0.263**
P_3	0.025	-0.067	0.208	0.056	-0.736**	0.374	-1.524**	-0.629**	-0.455**	-0.103	-0.359**	-0.306**
P_4	1.292**	1.067**	1.242**	1.200**	-0.847**	-1.021	-0.485**	-0.784**	0.279**	0.263**	0.234**	0.259**
P_5	-2.075**	-1.767**	-1.992**	-1.944**	2.303**	2.090**	2.039**	2.144**	0.579**	0.701**	0.878**	0.719**
P_6	0.692**	0.800**	0.908**	0.800**	0.474**	0.531	0.545**	0.516**	0.033	0.011	0.026	0.024
P_7	1.025**	2.267**	1.775**	1.689**	-1.508**	-1.579**	-1.926**	-1.671**	0.319**	-0.058	-0.197*	0.021
P_8	-1.208**	-1.700**	-1.525**	-1.478**	2.775**	3.154**	3.152**	3.027**	-0.169	-0.010	0.214**	0.012
L.S.D (gi) 5%	0.199	0.302	0.562	0.143	0.213	1.064	0.320	0.255	0.178	0.168	0.160	0.066
L.S.D (gi) 1%	0.259	0.392	0.731	0.187	0.277	1.383	0.416	0.334	0.232	0.219	0.208	0.087
L.S.D (gi-gj)5%	0.302	0.850	0.321	0.221	0.322	1.609	0.484	0.395	0.270	0.254	0.242	0.102
L.S.D (gi-gj) 1%	0.392	1.105	0.417	0.290	0.419	2.092	0.629	0.518	0.350	0.331	0.314	0.134

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

Table (10): Estimates of general combining ability effects for number of spikes/plant, number of grains/spike, 1000 kernel weight and grain yield/plant at three nitrogen levels as well as the combined data.

Parents	Number of spikes / plant				Number of grains / spike				1000 kernel weight				Grain yield / plant			
	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
P_1	1.090**	1.435**	1.466**	1.330**	-5.663**	-6.125**	-7.005**	-6.264**	-0.981**	-1.021**	-0.357**	-0.786**	0.467*	1.844**	2.383**	1.565**
P_2	-0.854**	-1.250**	-0.723**	-0.942**	-1.301**	-0.583	-1.190**	-1.024**	-1.343**	-2.254**	-1.615**	-1.737**	-0.616**	-0.857**	-1.053**	-0.842**
P_3	0.110	-0.161	-0.202	-0.084	2.301**	2.611**	2.557**	2.490**	-0.146	0.027	-0.358**	-0.159**	-0.481*	-0.485**	0.102	-0.288**
P_4	-1.165**	-1.447**	-1.550**	-1.387**	0.138	-1.240**	-0.300	-0.467**	0.460**	0.475**	0.496**	0.477**	-1.802**	-2.508**	-0.534**	-1.614**
P_5	-0.969	0.041	0.006	-0.307**	3.253**	2.889**	3.303**	3.148**	2.536**	2.295**	2.689**	2.507**	0.437*	-0.038	-0.044	0.118
P_6	1.180**	0.596**	1.282**	1.019**	0.186	1.160**	1.561**	0.969**	0.812**	1.315**	0.953**	1.026**	1.562**	1.783**	1.074**	1.473**
P_7	-0.086	0.128	-0.499*	-0.152*	1.498**	1.061*	1.684**	1.414**	-1.678**	-1.768**	-2.192**	-1.879**	-0.116	0.544**	1.117**	0.515**
P_8	0.694**	0.658**	0.219	0.524**	-0.412	0.227	-0.611**	-0.265*	0.339**	0.931**	0.385**	0.552**	0.549**	-0.283*	-3.046**	-0.927**
L.S.D (gi) 5%	0.337	0.253	0.415	0.133	0.423	0.841	0.451	0.235	0.251	0.193	0.243	0.090	0.387	0.272	0.265	0.122
L.S.D (gi) 1%	0.438	0.329	0.540	0.175	0.550	1.094	0.586	0.309	0.326	0.251	0.323	0.118	0.503	0.354	0.345	0.160
L.S.D (gi-gj)5%	0.510	0.383	0.628	0.207	0.640	1.272	0.682	0.365	0.379	0.292	0.367	0.071	0.585	0.411	0.401	0.189
L.S.D (gi-gj) 1%	0.662	0.498	0.816	0.271	0.832	1.654	0.886	0.478	0.493	0.379	0.488	0.071	0.760	0.535	0.521	0.248

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

for parents differed from nitrogen level to another. These findings coincided with that reached before, where significant GCA by N levels interaction mean squares were detected. However, it is clear that, the parent which possess high GCA effects for grain yield/plant might do so for one or more traits contributing to yield, while the parent which had high GCA effects for one or more for yield components not necessarily had high GCA effects for yield itself. It could be concluded that, the eight parental genotypes might be selected as parental materials in wheat breeding programs for one or more traits under low N level (25 kg N/fed.).

Specific combining ability effects

Estimates of the specific combining ability effects ($\hat{S}_{ij}$) for the twenty eight crosses evaluated at the three nitrogen fertilizer levels are presented in Tables 11 to 13. For heading date, ten, two, four and four cross combinations exhibited significant negative desirable effects for heading date at 25, 50, 75kg N/fed. as well as the combined data, respectively.

Concerning plant height towards shortness, twelve, five, nine and eleven crosses exhibited significantly negative desirable ($\hat{S}_{ij}$) at 25, 50, 75 kg N /fed as well as the combined analysis. The shortness of these parents and crosses could be attributed to the shortness of MELLAL-1, (P_3) and Gemmeiza10 (P_4) which may posses genes controlling shortness and the remaining lines or varieties which were involved in superior crosses were found to be among the poorest combiners for shortness.

Table (11): Estimates of specific combining ability effects (SCA) for heading date, plant height and spike length at three nitrogen levels as well as the combined data.

Genotypes	Heading date day				Plant height, cm				Spike length , cm			
	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
P_1xP_2	0.96**	2.267*	2.885**	2.038**	-6.26**	-3.231	-3.66**	-4.39**	0.430	0.956**	1.599**	0.995**
P_1xP_3	-1.30**	3.633**	3.419**	1.916**	-3.00**	-2.889	0.812	-1.69**	0.576*	0.267	-0.063	0.260
P_1xP_4	3.430**	2.500**	1.052**	2.327**	1.993**	3.176	-0.513	1.552**	1.052**	0.368	-0.050	0.457**
P_1xP_5	-1.54**	-4.67**	-4.72**	-3.64**	-2.40**	-1.158	0.527	-1.012	-0.338	0.347	0.613*	0.207
P_1xP_6	1.030**	1.767*	1.385**	1.394**	-2.12**	-2.916	-4.19**	-3.07**	-0.84**	-0.300	0.145	-0.330
P_1XP_7	-0.304	0.633	0.519	0.283	6.075**	4.828**	4.774**	5.226**	-0.141	-0.124	0.024	-0.080
P_1xP_8	-0.737*	-1.067	0.152	-0.551	2.159**	-0.003	0.013	0.723	0.173	-0.319	-0.83**	-0.325*
P_2xP_3	0.096	0.433	-2.02**	-0.495	-0.301	-2.417	0.704	-0.671	0.294	0.174	0.574*	0.347*
P_2xP_4	0.163	-1.033	-1.05**	-0.640*	2.033**	1.078	0.258	1.123	0.357	0.588*	0.001	0.315*
P_2xP_5	0.863**	0.133	0.185	0.394	6.606**	6.101**	7.108**	6.605**	-0.76**	-1.14**	-0.636*	-0.84**
P_2xP_6	-1.24**	-0.767	0.285	-0.573	3.266**	1.773	1.715**	2.251**	-0.391	-0.286	-0.424	-0.367*
P_2xP_7	0.430	-0.233	-0.581	-0.128	-1.73**	-1.390	-0.208	-1.108	0.440	0.026	0.325	0.264
P_2xP_8	-1.34**	-3.60**	-0.615	-1.85**	0.705*	0.513	-0.639	0.193	0.438	-0.106	0.101	0.144
P_3XP_4	-1.77**	-0.667	3.819**	0.460	-0.427	-2.586	-0.560	-1.191*	0.510	0.509	1.186**	0.735**
P_3xP_5	0.596	-0.833	-0.95**	-0.395	2.857**	-0.547	2.790**	1.700**	-0.484	-0.73**	-0.008	-0.41**
P_3XP_6	0.496	-0.733	-0.515	-0.251	5.363**	3.736*	4.741**	4.613**	-0.615*	-0.94**	-0.81**	-0.79**
P_3xP_7	1.163**	-0.200	0.619	0.527	-5.79**	-6.87**	-7.03**	-6.56**	1.013**	1.434**	1.437**	1.295**
P_3xP_8	2.396**	2.767**	1.919**	2.360**	-1.95**	-4.101*	-2.12**	-2.72**	-0.96**	-0.645*	0.276	-0.44**
P_4xP_5	-1.00**	1.367	-0.648	-0.095	-3.21**	-3.992*	-5.16**	-4.11**	-0.358	-0.681*	-0.428	-0.49**
P_4xP_6	1.230**	1.133	0.452	0.938**	-2.33**	-2.760	-4.05**	-3.05**	0.455	0.198	-0.460	0.064
P_4XP_7	-0.770*	1.333	0.252	0.272	2.135**	4.577**	4.876**	3.863**	-0.83**	0.008	-0.137	-0.319*
P_4xP_8	1.463**	2.300**	1.885**	1.883**	0.953**	-0.283	-0.026	0.215	0.660*	1.132**	1.262**	1.018**
P_5xP_6	0.596	1.633	2.352**	1.527**	-3.05**	-3.924*	-5.11**	-4.03**	0.795**	0.204	0.890**	0.630**
P_5xP_7	-0.737*	4.833**	4.485**	2.860**	-8.76**	-7.36**	-9.35**	-8.49**	0.449	0.780**	-0.141	0.363*
P_5xP_8	2.496**	9.133**	8.785**	6.805**	-2.00**	-2.484	-2.44**	-2.307**	0.294	0.582*	0.795**	0.557**
P_6xP_7	-0.504	3.600**	2.919**	2.005**	0.655*	1.719	1.406**	1.260*	-0.055	-0.440	0.281	-0.071
P_6xP_8	-1.94**	-1.433	-0.448	-1.27**	-0.574	0.895	-0.669	-0.116	1.053**	1.421**	0.857**	1.110**
P_7xP_8	1.730**	-0.233	1.019**	0.838**	3.454**	3.068	4.495**	3.672**	0.854**	1.217**	1.713**	1.262**
L.S.D(sij)5%	0.611	1.723	0.650	0.634	0.653	3.262	0.981	1.133	0.547	0.516	0.490	0.293
L.S.D(sij)1%	0.813	2.292	0.865	0.831	0.869	4.339	1.305	1.486	0.727	0.686	0.652	0.384
L.S.D (sij-sik)5%	0.905	2.550	0.962	0.938	0.967	4.827	1.452	1.677	0.809	0.763	0.725	0.434
L.S.D (sij-sik)1%	1.203	3.391	1.279	1.230	1.286	6.420	1.931	2.198	1.076	1.015	0.964	0.569

* and ** significant at 0.05 and 0.01 levels of probability, respectively.

Table (12): Estimates of specific combining ability effects (SCA) for number of spikes/plant and number of kernels/spike at three nitrogen levels as well as the combined data.

Genotypes	Number of spikes / plant				Number of kernels / spike			
	N1	N2	N3	Comb	N1	N2	N3	Comb
P_1xP_2	1.160*	1.224**	-1.160	0.408	-3.125**	1.282	1.155	-0.230
P_1xP_3	-0.377	0.808*	1.042	0.491	5.849**	5.531**	5.299**	5.560**
P_1xP_4	2.064**	1.614**	3.547**	2.409**	-6.077**	-7.825**	-9.177**	-7.693**
P_1xP_5	0.486	0.606	0.634	0.575	12.43**	11.85**	10.77**	11.68**
P_1xP_6	-1.587**	-1.622**	-0.509	-1.239**	1.348*	1.665	8.008**	3.674**
P_1XP_7	-1.247*	-0.814*	0.079	-0.661*	-7.170**	-8.529**	-10.325**	-8.675**
P_1xP_8	-0.164	-0.654	0.078	-0.247	-1.150	-1.622	-3.440**	-2.071**
P_2xP_3	-0.547	0.270	-1.763**	-0.680*	0.894	-2.024	-1.563*	-0.898
P_2xP_4	-0.488	-0.534	2.656**	0.544	-0.720	-0.334	-0.599	-0.551
P_2xP_5	2.436**	1.741**	2.653**	2.277**	5.865**	8.858**	5.401**	6.708**
P_2xP_6	-0.183	1.716**	3.350**	1.628**	-1.353*	-1.223	-0.871	-1.149*
P_2xP_7	-0.183	0.551	1.587*	0.652*	-4.190**	-8.184**	-12.417**	-8.264**
P_2xP_8	2.310**	0.930*	4.160**	2.467**	4.344**	5.027**	9.888**	6.419**
P_3XP_4	0.331	-0.420	-2.502**	-0.864**	-0.132	2.479	3.671**	2.006**
P_3xP_5	1.946**	1.068**	2.465**	1.826**	-0.480	-3.069*	-3.609**	-2.386**
P_3XP_6	-1.180*	-0.516	0.119	-0.526	1.097	-2.737*	-7.994**	-3.211**
P_3xP_7	1.026	1.565**	3.233**	1.941**	3.665**	5.509**	9.809**	6.328**
P_3xP_8	0.122	-1.262**	-0.335	-0.491	-4.045**	0.563	1.088	-0.798
P_4xP_5	-1.436**	-0.072	0.693	-0.272	-7.556**	-7.042**	-7.522	-7.374**
P_4xP_6	1.638**	0.487	2.471**	1.532**	6.384**	1.656	3.860**	3.967**
P_4XP_7	-0.936	-0.932*	-3.489**	-1.786**	2.152**	2.329	1.740*	2.074**
P_4xP_8	0.554	-0.339	-2.150**	-0.645*	4.732**	4.806**	4.879**	4.806**
P_5xP_6	2.439**	0.058	-0.879	0.540	-6.448**	-4.269**	-11.09**	-7.269**
P_5xP_7	1.926**	-0.614	-0.162	0.383	3.379**	4.411**	8.213**	5.334**
P_5xP_8	-3.241**	-0.131	-1.919**	-1.764**	-3.296**	-4.759**	5.319**	-0.912
P_6xP_7	-0.520	-0.338	0.049	-0.270	-1.986**	4.059**	12.62**	4.897**
P_6xP_8	0.293	0.295	1.835**	0.807**	1.838**	0.743	1.031	1.204*
P_7xP_8	-0.224	0.272	-3.705**	-1.219**	2.486**	-0.924	-7.249**	-1.896**
L.S.D(sij)5%	1.033	0.776	1.273	0.593	1.298	2.579	1.383	1.046
L.S.D(sij)1%	1.374	1.032	1.693	0.777	1.726	3.430	1.839	1.371
L.S.D (sij-sik)5%	1.529	1.148	1.883	0.877	1.920	3.816	2.046	1.547
L.S.D (sij-sik)1%	2.033	1.527	2.505	1.150	2.554	5.075	2.721	2.029

Table (13): Estimates of specific combining ability effects (SCA) for 1000-kernel weight and Grain yield/plant at three nitrogen levels as well as the combined data.

Genotypes	1000 - kernel weight				Grain yield / plant			
	N1	N2	N3	Comb	N1	N2	N3	Comb
P_1xP_2	-1.452**	-2.344**	-2.516**	-2.104**	0.656	2.555**	2.613**	1.941**
P_1xP_3	-2.072**	-0.952**	1.027**	-0.666**	4.915**	-0.380	-2.208**	0.775**
P_1xP_4	-1.408**	-1.307**	-0.597	-1.104**	-0.291	3.893**	-3.106**	0.165
P_1xP_5	-1.291**	0.280	-0.124	-0.378	1.927**	2.240**	3.725**	2.630**
P_1xP_6	1.040**	2.300**	1.372**	1.571**	-1.101	-3.991**	-0.427	-1.840**
P_1XP_7	2.543**	2.380**	1.991**	2.304**	-2.706**	-2.319**	-3.290**	-2.772**
P_1xP_8	0.879*	0.547	0.330	0.586**	0.412	0.201	5.213**	1.942**
P_2xP_3	-0.220	-0.775*	-0.362	-0.452*	3.971**	-0.527	-1.772**	0.557*
P_2xP_4	0.864*	1.233**	1.664**	1.254**	3.414**	2.406**	-3.893**	0.642*
P_2xP_5	1.731**	1.173**	3.167**	2.024**	1.402*	5.680**	4.508**	3.863**
P_2xP_6	-0.501	-0.984**	-1.646**	-1.043**	-0.152	0.736	0.156	0.246
P_2xP_7	0.229	-0.688*	-0.658	-0.372	-0.561	-1.698**	-0.213	-0.824**
P_2xP_8	0.322	0.793**	-0.475	0.213	1.834**	2.212**	5.916**	3.320**
P_3XP_4	-0.439	-0.095	0.284	-0.083	-3.880**	-1.799**	-5.955**	-3.878**
P_3xP_5	-1.396**	-0.038	-0.676	-0.703**	-4.775**	1.561**	2.179**	-0.345
P_3XP_6	3.312**	1.832**	1.124**	2.089**	-2.380**	-1.773**	-0.032	-1.395**
P_3xP_7	2.815**	3.428**	3.492**	3.245**	6.458**	6.683**	11.87**	8.336**
P_3xP_8	-0.865*	-1.454**	-1.505**	-1.275**	1.440*	0.973*	-2.646**	-0.078
P_4xP_5	-0.018	0.463	0.143	0.196	2.328**	-2.102**	10.26**	3.49**
P_4xP_6	-0.063	0.370	0.810*	0.372	3.170**	5.184**	3.050**	3.801**
P_4XP_7	-1.384**	-2.554**	-1.759**	-1.899**	-3.638**	-4.861**	1.397**	-2.367**
P_4xP_8	2.279**	2.067**	1.348**	1.898**	0.690	2.966**	-6.370**	-0.905**
P_5xP_6	0.710	0.537	1.096**	0.781**	0.915	-1.063*	-2.803**	-0.984**
P_5xP_7	0.173	0.693*	0.594	0.487*	-0.460	1.350**	-3.819**	-0.977**
P_5xP_8	0.519	-0.140	0.514	0.298	-5.122**	-2.420	0.770	-2.257**
P_6xP_7	-0.912*	-0.994**	-1.649**	-1.185**	0.075	5.529**	-3.074**	0.843**
P_6xP_8	-0.903*	-0.643*	0.334	-0.404*	-0.607	0.699	3.079**	1.057**
P_7xP_8	-0.303	0.440	0.029	0.055	-1.505*	-4.125**	-10.317**	-5.316**
L.S.D(sij)5%	0.769	0.591	0.744	0.399	1.186	0.834	0.813	0.543
L.S.D(sij)1%	1.023	0.786	0.989	0.524	1.577	1.109	1.081	0.712
L.S.D (sij-sik)5%	1.138	0.875	1.101	0.591	1.755	1.234	1.203	0.803
L.S.D (sij-sik)1%	1.513	1.163	1.464	0.775	2.334	1.641	1.600	1.053

With regard to spike length, seven, eight, ten crosses exhibited significant positive ($\hat{S}_{ij}$) at 25, 50, 75 kg N/fed. The two parents; LAKATA-1 (P_2) and Sakha 94 (P_3) which were involved in the superior crosses were found to be among the poorest combiners, but the parental varieties; NABEK- 4 (P_4) and Gemmeiza 7 (P_5) at the three levels and Gemmiza 10 under low nitrogen level were found to be good combiners for this trait. For the combined data, twelve crosses had this advantage, i.e. P_1xP_2, P_1 x P_4, P_2 x P_3, P_2 xP_4, P_3 x P_4, P_3 x P_7, P_4 x P_8, P_5 x P_6, P_5 x P_7, P_5 x P_8, P_6 x P_8 and P_7 x P_8. These results agreed with those found by Rajara and Maheshwari (1996), Salgotra *et al.* (1997), Mehta *et al.* (1998), Pandey *et al.* (1999), Soylu (2003), Khan and Ali (1998), and EL-Hosary *et al.* (2000) for heading date, plant height and spike length.

For number of spikes per plant, eight, eight, ten and nine crosses exhibited significantly positive ($\hat{S}_{ij}$) at 25, 50, 75 kg N/fed. and the combined analysis. The two parental varieties; LAKTA-1(p_2) and Gimmeiza7 (p_5) which were involved in the superior crosses were found to be among the poorest combiners for this trait. The crosses;P_1x P_2, P_1x P_4, P_2 x P_5,P_2 x P_8, P_3 x P_5, P_4 x P_6, P_5x P_6 and P_5 x P_7 at 25 kg N /fed. were the best ones. These results were in agreement with those found by Mekhamer (1995), Mahrous (1998), and Soylu (2003).

For number of kernels per spike, twelve, eight, thirteen and thirteen crosses exhibited significantly positive ($\hat{S}_{ij}$) at 25, 50, 75 kg N/fed. and the combined analysis, respectively. The three parental lines; CHAM-6 / MayoN"s"(p_1), LAKTA-1 (p_2) and Sakha 94 (p_8) which were involved in the superior crosses were found to be among the poorest combiners, but the parental variety; Gemmeiza7 was a good combiner for this trait. The crosses ;P_1x P_3, P_1x P_5, P_1 x P_6, P_2 x P_5, P_2 x P_8, P_3 x P_7, P_4 x P_6, P_4 x P_7,P_4 x P_8, P_5x P_7, P_6 x P_8 and P_7 x P_8 at 25 kg N / fed. Had significant ($\hat{S}_{ij}$). These results were in the same trend with those obtained by Mekhamer (1995), and Mehta *et al.* (1998).

For 1000 – kernel weight eight, nine, ten and ten crosses exhibited significantly positive ($\hat{S}_{ij}$) at 25, 50, 75 kg N/fed. and the combined analysis, respectively. However, the crosses; P_1x P_6, P_1x P_7, P_1x P_8, P_2x P_4, P_2x P_5, P_3x P_6, P_3 x P_7 and P_4 x P_8 at 25 kg N / fed. had high ($\hat{S}_{ij}$). These results were in the same trend with those obtained by Mehta *et al.* (1998), and Pandey *et al.* (1999).

For grain yield per plant, ten, thirteen, eleven and thirteen crosses exhibited significantly positive ($\hat{S}_{ij}$) at 25, 50, 75 kg N/fed. and the combined analysis, respectively. It is of interest to mention that the two parental lines; LAKTA-1 (P_2) NABEK-4 (P_4) which were involved in the superior crosses were found to be among the poorest combiners. On the other hand, the parental lines; Gimmeiza 9 (P_6) under low and high N levels and Sakha 94 (P_8) under low N level (25 kg N/fed.) were good combiners for this trait.

However, the crosses; P_1x P_3, P_1x P_5, P_2x P_3, P_2 x P_4, P_2 x P_5, P_2 x P_8, P_3 x P_7, P_3 x P_8, P_4 x P_5 and P_4 x P_6 at 25 kg N / fed. were the best crosses from their ($\hat{S}_{ij}$) point of view. These results agreed with those found by Khan *et al.* (1995), and Soylu (2003).

The crosses showing high ($\hat{S}_{ij}$) in most important traits could be used in hybrid cultivar breeding when available, while the parents exhibiting high (ĝi), could possessing high amounts of additive genetic variance, and could be used in selection programs.

In conclusion, these results obtained herein concerning general and specific combining ability effects would indicate that the parental lines; Gemmmeiza 7, Gemmmeiza10 and Sakha 94 expressed significant desirable (ĝi) under low N level and the excellent hybrid combinations could be obtained from three possible combinations between the parents, i.e high x high, high x low and low x low combiners. Most the previous crosses under low nitrogen level (25 kg N /fed) could be used in breeding program for traditional breeding procedures.

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تقدير القدرة على التآلف للموارد الشحيحه فى بعض هجن القمح

السيد حامد الصعيدي[1]، رمضان علي الرفاعي[1]، أسعد احمد حمادة[2]، سليمان عبد المعبود عرب[2]
[1]جامعة طنطا، كلية الزراعة، قسم المحاصيل، مصر
[2]البنك القومي للجينات والموارد الوراثية، قسم المحاصيل، مصر

الملخص العربـــى

أقيمت التجربة في محطة البحوث الزراعية بالجميزة ـــ مصر خلال الموسمين الزراعيين 2003 / 2004, 2004 / 2005. وقد استخدم في هذا البحث نظام الهجن الدائرية لثماني تراكيب وراثية من القمح في اتجاه واحد تحت ثلاثة معدلات مختلفة من التسميد النتروجيني. ويهدف هذا البحث إلي تقدير كل من القدرة العامة والقدرة الخاصة علي الائتلاف, وكذلك التفاعلات بينهما للصفات التالية تاريخ التزهير, طول النبات, طول السنبلة, عدد السنابل للنبات, عدد الحبوب في السنبلة, وزن الألف حبة, محصول الحبوب للنبات. وقد أظهرت النتائج أن هناك اختلافات معنوية لجميع الصفات عند تقدير التباين لكل من الآباء مع الهجن مما يوضح أن متوسط قوة الهجين معنوية لجميع الصفات, و أن التباين الراجع الى القدرة العامة والخاصة علي الائتلاف كانت أيضا عالية المعنوية لجميع الصفات المدروسة تحت الثلاثة معدلات المختلفة من التسميد النتروجيني والتحليل المشترك بينهم, وقد أظهرت النتائج أيضا أن نسبة القدرة العامة مقسومة علي القدرة الخاصة علي الائتلاف أكبر من الواحد الصحيح مما يدل علي أن ذلك يرجع إلى الفعل المضيف وذلك لجميع الصفات مما يدل علي جدوى الانتخاب في الأجيال الانعزالية المبكرة نتيجة الفعل المضيف.

أوضح التباين المشترك بين معدلات التسميد وكل من القدرة العامة والخاصة علي الائتلاف اختلافات معنوية لكل الصفات المدروسة عدا صفة طول النبات للقدرة العامة علي الائتلاف. وأظهرت النتائج أن الآباء الثلاثة التالية جميزة 9, وجميزة 10, "CHAM-6 / MayoN"s لهم قدرة عالية علي التالف لتحسين صفة محصول الحبوب تحت معدلات التسميد الثلاث المختلفة، أما الصنف جميزة 10 فقد كان له قدرة عامه على التآلف وذلك لتحسين صفة طول السنبلة، وكذلك الصنف سخا 94 لتحسين صفة المحصول تحت ظروف التسميد المنخفض. كما أوضحت النتائج أنه يمكن الحصول علي بعض الهجن التي لها قدرة خاصة علي التالف لتحسين صفة التبكير ومحصول الحبوب وبعض مكونات المحصول تحت معدلات التسميد الثلاث المختلفة.

من نتائج هذه الدراسة أمكن التوصل إلي أن هناك بعض الآباء التي لها قدرة عامة علي الائتلاف, وكذلك بعض الهجن التي لها قدرة خاصة علي الائتلاف لصفة التبكير والمحصول وبعض مكوناته والتي يمكن إدخالها في برامج تربية القمح تحت ظروف التسميد المنخفض (25 وحدة أزوت /فدان) لتقليل التلوث النتراتى.