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BREEDING MEASURMENTS FOR HEADING DATE , YIELD AND YIELD COMPONENTS IN WHEAT USING LINE X TESTER ANALYSIS

[38]

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ABSTRACT

The presnt study was carried out under the field conditions at Al-Gemmeiza Agricultural Research Station ,during 2000/2001and 2001/2002 winter seasons to evaluate thirty five introduced wheat lines which were crossed with four local wheat cultivars, Sids 4, Gemmeiza 9, Giza 168 and Sakha 93 as testers (T_1, T_2, T_3 and T_4, respectively) to produce 140 crosses using line x tester to estimate heterosis ,combining ability effects and gene effects for heading date ,plant height ,spike length ,number of spikes/plant ,number of kernels / spike, 1000-kernel weight and grain yield / plant. The studied genotypes, i.e, parents, parents vs crosses , crosses, Lines ,testers and lines x testers exhibited highly significant variance for all traits studied except spike length and number of spikes / plant for lines x testers. The results revealed that the additive gene effects were larger than those of the non additive and played the major role in the inheritance for all traits studied, except heading date and plant height. The parental lines 1, 6, 11, 25, 30 and 32 were the best combiners for yield and yield components and might be selected as parental materials for wheat breeding programmes. However,the hybrids L_{30} x T_4 and L_{32} x T_4 had the highest significant for yield and its components for better parent and specific combining ability effects. Heritability in broad sense (T_b%) was high and exceeded 70 for all studied traits except for spike length where its value was moderate. However narraw sense heritability was high (more than 50%) for plant height, number of spikes / plant, number of kernels / spike, 1000-kernel weight and grain yield / plant and was moderate (30-50%) for heading date and spike length. The highest expected gain expressed as a percentage of the mean was rather high for number of spikes / plant (56.028%) followed by grain yield /plant (54.415%), number of kernels /spike (37.09%), 1000-kernel weight (13.88%), heading date (8.711%), spike length (8.341%) and plant height (8.096%) which showed low genetic gain.

Key words: Combining ability, Heterosis, Hertability, Wheat cultivars

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INTRODUCTION

Wheat is one of the most important major cereal crops allover the world .In Egypt, it is used as stable food grain for urban, rural and bedim societies and as a major source of straw for animal feeding .The procedure developed by **Kempthorne (1957)** as lines x testers analysis to provide information about general and specific combining ability variances and thus the type of gene action controlling the economic traits is still widely used.

Combining ability analysis gives very useful information with regard to selection of parents based on the performance of their hybrids for the development of hybrids. Moreover, this analysis helps the breeders to identify the best combiners which may be hybridized either to exploit heterosis or to build up the favorable fixable genes .In the initial stages of breeding programme the breeders need general knowledge about gene action and genetic system controlling the genetic variation of the studied characters .The Lines x tester analysis was used to estimate both general combining ability effects (G.C.A.) and specific combining ability effects (S.C.A.) for yield and its components and important agronomic traits of wheat by several authors such as **Hassan and Abd El-Moniem (1991); Salem and Hassan (1991); Singh *et al* (1994); Gupta & Ahmad (1995); Rajara and Maheshwari (1996).**

Many authors studied heterotic effects on yield and yield components such as **Hamada *et al* (1997); El-Hosary *et al* (2000) Ashoush *et al* (2001) and Abd El-Aty & Katta (2002).** They reported that heterotic effects were positive and significant for spike length, number of spikes / plant, number of kernels /spike, 1000-kernel weight and grain yield /plant

In addition, various values of heritability estimates for wheat yield and its contributing traits were reported by many workers, as; **Salem and Hassan (1991); El-Marakby *et al* (1993); Al-Kaddoussi *et al* (1994); Kheiralla *et al* (2001) and El-Morshidy *et al* (2001).**

Therefore, the work reported herin was carried out to estimate the magnitude of heterosis, general and specific combining ability variances, additive and dominance gene effects as well as heritability and expected genetic advance for yield and its components using line x tester analysis.

MATERIAL AND METHODS

This study was conducted during the two growing seasons, 2000/ 2001 and 2001/2002 at Al-Gemmeiza Agriculture Research Station to estimate some breeding parameters in bread wheat for grain yield and its contributing characters using line x testers analysis. In 2000/2001 season, thirty five introduced wheat lines (L) were crossed with four local wheat cultivars, Sids 4 , Gemmeiza 9, Giza 168 and Sakha 93 as testers (T) to produce 140 crosses. The pedigree of parental genotypes are presented in Table (1). In 2001/2002 season, the 140 F1 crosses and their parental (35 lines and 4 testers) genotypes were evaluated for grain yield and its contributing characters using a randomized complete block design with three replications. Each plot included three rows, 3 m. long and 30 cm. width and plants were spaced at 10 cm. within row for each studied genotype. The recommended agricultural practices were

Table 1. The names and pedigrees of the parental genotypes.

Genotype	Pedigree	Origin
Lines (L)		
1	Weaver CM90320 –A-1B-4y-OB	Mexico
2	Zidane 89 /Kapsw ICW95-OO27	ICARDA
3	Dobuc-2 CM58808-1AP-2AP-1AP-4AP-OAP	ICARDA
4	Cham 4	Syria
5	W3918 A/Jup//GRU 90 –201736 ICW 91 –0147-OTS-5AP-OTS-OAP	Mexico
6	Attila CM 85836 – 4Y-OM-OY-6M-OY	Mexico
7	Kauz*2/YACO??KAUZ CRG 866-8Y-O1OM-OY	Mexico
8	Zarzour /Prew ICW 95 O100	ICARDA
9	Seri 82//Shi#4414 /Crow's ICW 89 –0018-7AP-OAP-1AP-OTS-4AP-OTS-OAP	Mexico
10	Tjb 368 .251/BUC//CUPE CM SW89Yoo308-8Y-2M-3Y-OB	Mexico
11	Dove 's'/Buc's'//WW1203	ICARDA
12	Debeira	India /Syria
13	Turaco /chil CM92354-62M-OY-OM-3Y-OB-1B-OY	Mexico
14	Mtl's' /Sham 4 ICW88-O162-1AP-OL-Obr-Obr-2AP-OAP	ICARDA
15	Baviacora N92 CM92066-J-OY-OM-OY-4 M-OY-OMEX	Mexico
16	Kavko	Kenya
17	Hys/T2484-35T-2T-1T OWW67033-o4P-1H-2S-OH	U.S.A
18	Cham 4 //Gh's' /Bow's' ICW89 –0012-8AP-OAP-1AP – OTS-2AP-OTS-OAP	ICARDA
19	Laj 2965 //Shi#4414/Crow's'	Mexico/Syria

Table 1. Cont.

Genotype	Pedigree	Origin
20	Seri 82 CM 33027-F-15N-500Y-ON-87B-OY	Mexico
21	Tia .3 CIGM 81 .69-16B-4Y-3B-2Y-1B-1Y-5B-OY	Mexico
22	Kauz's//Bow's'/ cm 64798.7H.3H	ICARDA
23	Kavz's'//Kea's'/Tan's'	ICARDA
24	Vee 3 7 Kauz's'	ICARDA
25	Koel's'/Vee's' CM64708-2AP-2AP-1AP-OAP	Syria
26	Karawan-2 SWM 6828-6AP-2AP-2AP-1AP-2AP-1AP-OAP	ICARDA
27	AI Fon# 4//Maya 74 /Pvn's' SWM10896-8Y-2Y-OY-1AP-OAP	Mexico/Syria
28	Prl's'/Toni//Attila Cgm7146-3GM-2GM-4GM-OGM	Egypt
29	Van's' //Bb/Kal/3/Ns732/Her ICW 94 - 0195	ICARDA
30	Parus CRG 68 –C-10Y-3B-OY	Mexico
31	Buc'S'/Flk's' CM 50070-24Y-1M-1Y-OY	Mexico
32	Tow's'/Pew's'// V2 (Moroco)#2 ICW 94 –O252	ICARDA
33	Khyber 79	Pakistan
34	Falke CM56744 –7Y-2Y-1M-1Y-OM-OBGD	Mexico
35	Narch 8	Morocco
Testers (T)		
1	Sids 4 Maya "s"/Mons//CMH74A-592/3/Giza157*2 SD10001-2sd-3sd-2sd-0sd	Egypt
2	Gemmeiza 9 Ald's'/Huac//CMH 74 A.630/Sx CGm 4583-5Gm-1Gm-OGm	Egypt
3	Giza 168 MRL/BUC//SERI CM93046-8M-0Y-0M-2Y-0B-0GZ	Egypt
4	Sakha 93 Sakha92/TR810328 S8871-1S-2S-1S-0S	Egypt

applied at the proper time. Heading date was recorded at the time of ear emergence. At harvest time, 20 individual guarded plants from each parental genotypes and F1 were used to record data for the following characters: plant height, spike length, number of spikes / plant, number of kernels /spike, 1000-kernel weight and grain yield / plant .

The obtained data were subjected to the biometrical analysis using the procedure of line x tester analysis as outlined by **Kempthorne (1957)**. General and specific combining ability variances, gene effects, broad and narrow sense heritability and genetic advance as percentage of the population mean for the studied characters were estimated as described by **Mather and Jinks (1982).**

RESULTS AND DISCUSSION

1. Analysis of variance

The analysis of variance for all traits studied are presented in Table (2). Genotypes i.e. parents and crosses exhibited highly significant variation for all traits studied, indicating differences among these thirty nine genotypes under investigation. Data presented in Table 2, show that mean squares of parents vs crosses (which indicated the variance due to heterosis) were found to be highly significant for all characters illustrating the wide range of heterosis values among the hybrids for all traits. Further partitioning of crosses mean squares i.e. line x tester analysis indicated that the difference due to both lines and testers were highly significant for all characters. The contribution of lines x testers interaction were found to be highly significant for all traits studied except spike length and number of spikes / plant indicating that testers did not express similar orders of ranking according to the performance of their crosses with the four testers. Also, the results in Table (2) reveal that the GCA / SCA ratio exceeded the unity for most traits studied ,indicating that the nature of the gene effects was predominantly additive for spike length, number of spikes/plant number of kernels / spike, 1000-kernel weight and grain yield /plant. On the other hand, this ratio was less than unity for heading date and plant height, indicating that SCA variance was more important than GCA variance and that the non–additive variance was the predominant variance component controlling the inheritance of both traits. It is evident that the presence of large amount of additive effects suggests the potentiality for obtaining high yield and yield components and improving these components. Also, selection procedures based on the accumulation of additive gene effect would be successful in improving all characters studied. The obtained results are in harmony with those previously reached by **Bhullar *et al* (1981), Srivastava *et al* (1982); Qualser *et al* (1985); Al-Kaddoussi *et al* (1994) and El–Adl *et al* (1996).**

It is worth to mention that the proportional contribution of the lines ,testers and their interaction to the total variance varied according to the studied characters. The proportional contributions of the studied lines varied from 22.792% of the total variation of the studied crosses for grain yield / plant to 68.231% for heading date. However, the highest contribution value for the studied testers was 55.884% for grain yield / plant. The proportional of line x tester contribution to the total variation ranged from 7.573% for

Table 2. Mean squares for heading date , yield and yield components in wheat and their contribution to the total variation.

Sources of variation	d.f	Heading date	Plant height	Spike length	No.of spikes / plant	No.of kernels / spike	1000-kernel weight	Grain yield / plant
Replications	2	19.575	22.155**	8.075**	22.810**	52.515**	1.416	0.082
Genotypes	178	223.92**	133.781**	3.163**	9.999**	533.671**	31.585**	44.447**
Parents	38	177.688**	125.311**	1.374*	7.765**	642.275**	28.504**	13.324**
Parents Vs crosses	1	1676.094**	657.107**	159.787**	4.218**	323.578**	449.730**	1344.436**
Crosses	139	226.116**	132.332**	2.526**	10.652**	505.492**	29.419**	43.603**
Lines	34	630.740**	279.551**	4.842**	25.208**	1005.548**	80.924**	40.630**
Testers	3	567.640**	689.890**	17.368**	170.478**	6656.34**	218.587**	1129.035**
Lines x testers	102	81.196**	66.860**	1.317	1.099	157.899**	6.688**	12.670**
Error	356	19.328	2.612	0.866	1.024	14.259	0.290	1.027
GCA		8.854	7.142	0.167	0.049	62.787	2.445	9.780
SCA		20.622	21.415	0.150	0.025	47.879	2.132	3.880
GCA/SCA	----	0.429	0.333	1.113	1.960	1.311	1.146	2.520
Proportional contribution to the total variation								
Contribution of lines	----	68.231	51.672	46.890	57.886	48.657	67.282	22.792
Contribution of testers	----	5.418	11.251	14.838	34.540	28.420	16.035	55.884
Contribution of linesxtesters	----	26.350	37.075	38.270	7.573	22.921	16.682	21.323

* and ** indicate significant at 0.05 and 0.01% level of probability, respectively.

number of spikes / plant to 38.270% for spike length .

2. Heterosis

Heterosis expressed as the percentage deviation of F1 mean values from better parent values for yield and yield components is presented in Table (3). Significant positive heterotic effect relative to better parents values would be of interest for most traits under investigation, while for heading date and plant height high negative values would be useful from the breeders point of view. In this respect, thirty one out of 140 crosses showed significant negative heterotic effects relative to better parent for heading date and ranged from -7.441% in cross (L_{15} x T_3) to –22.399 % in cross (L_{26} x T_3). However, twenty nine crosses showed negative heterotic effects for plant height and ranged from –2.830% in cross (L_{34} x T_2) to –19.082% in cross (L_{35} x T_2). For spike length, the better parent heterosis was mostly positive and significant in most of the hybrids .Regarding number of spikes /plant, twenty eight hybrids showed positive significant desirable heterotic effects which ranged from 2.338% in cross (L_{26} x T_1) to 51.769 % in cross (L_{29} x T_1)relative to the respective better parent.Twenty two hybrids showed significant desirable heterosis which ranged from 6.217% in cross (L_2 xT_3) to 29.845% in cross(L_8 xT_3) relative to the respective better parent for number of kernels /spike. For 1000- kernel weight thirteen hybrids expressed significant positive heterotic effects relative to better parent values and ranged from 1.107% in cross (L_{12} x T_1) to 8.964% in cross (L_{33} x T_2) comparing to the better parent, forty five hybrids for grain yield /plant expressed significant positive heterotic effects which ranged from 1.713% in cross (L_{15} xT_1) to 24.018 % in cross (L_{27} x T_1) .Heterosis would be of economical value when the F1 hybrid exceeds its better parents, thereat, if the breeder planned a programme of selection in the advanced segregating generation from such superior specific hybrids, the expected improvement would be fruitful.

Several studies have also demonstrated significant levels of heterosis in wheat (**Hassan and Abd-El-Moniem 1991; Khan *et al* 1995; Rajara and Maheshwari 1996); Hamada *et al* 1997; Prassed *et al* 1998 and El-Seidy and Hamada, 2000**). They stated that genetic diversity is important for heterotic expression. Therefore, the level of heterosis expressed in this study may reflect a high degree of genetic diversity among these parents.

3. Combining ability

a. General combining ability effects

Estimates of the general combining ability effects (GCA) for the four testers and thirty five lines for seven traits studied are presented in Table (4). High positive values of general combining ability effects would be of interest in most traits ,while, for heading date and plant height, high negative values would be useful from the plant breeder point of view. The results revealed that lines number 1, 11, 12, 14, 20, 26, 27, 29 and 35 are considered as good donors for earliness, while 1, 3, 7, 26, 27, 30, 31, 32, 34 and 35 for shortness. On the other hand, wheat lines number 1, 5, 9, 12, 19, 32 and 35 gave positive general combining ability effects for spike length.

Table 3. Heterosis percentage relative to better parent for the seven characters studied in wheat crosses .

Characters / Genotype	Heading date	Plant height	Spike length	Number of spikes / plant	Number of kernels / spike	1000-kernel weight	Grain yield / plant
$L_1 x T_1$	-8.287*	-14.715**	27.019**	-1.435	-6.009	-10.534	-3.818
$L_1 x T_2$	-10.624**	0.453	11.675**	-19.355	-3.345	-4.868	7.345**
$L_1 x T_3$	-10.405**	-6.024**	23.275**	-4.912	4.228	2.020**	8.689**
$L_1 x T_4$	-12.705**	-6.297**	19.224**	-12.621	3.482	-4.411	-3.852
$L_2 x T_1$	-3.890	-7.389**	15.208**	-18.182	-18.191	-13.215	-4.889
$L_2 x T_2$	-1.489	2.215	2.284**	-17.742	-18.080	-5.023	1.797*
$L_2 x T_3$	0.388	-4.845**	8.583**	-27.368	6.217**	-5.763	0.703
$L_2 x T_4$	16.997	-9.846**	3.608**	-19.417	14.315**	-5.623	-16.314
$L_3 x T_1$	4.973	-8.573**	15.320**	-39.235	-2.132	-15.755	3.675**
$L_3 x T_2$	2.234	1.925	1.269	-40.86	-2.923	-10.278	-17.501
$L_3 x T_3$	-1.240	-8.543**	8.605**	-45.965	2.950	-9.056	-12.155
$L_3 x T_4$	32.847	-7.677**	5.671**	-45.307	0.041	-10.449	-5.891
$L_4 x T_1$	-21.670**	-3.401**	5.849**	10.899**	-13.635	-10.252	-11.135
$L_4 x T_2$	8.496	2.278	-4.060	-38.172	-14.954	-5.486	0.108
$L_4 x T_3$	10.087	-0.353	8.308**	-30.526	-18.425	-6.212	-3.492
$L_4 x T_4$	34.878	-2.254	2.686**	-27.832	-21.408	-6.114	-17.221
$L_5 x T_1$	-5.408	0.472	15.598**	-34.440	-12.375	-13.991	10.099**
$L_5 x T_2$	-2.606	2.969	3.553**	-38.978	-4.655	-8.964	-10.023
$L_5 x T_3$	0.413	1.889	16.913**	-26.316	9.601**	-9.805	-12.155
$L_5 x T_4$	16.732	1.417	14.626**	-29.450	7.307*	-9.287	-2.870
$L_6 x T_1$	-3.832	-1.317	21.487**	-13.418	0.484	-8.770	17.813**
$L_6 x T_2$	10.358	-7.608**	-8.629	-26.613	-0.866	-1.700	1.917*
$L_6 x T_3$	6.681	5.797	4.132**	-17.895	27.555**	-4.191	-2.544
$L_6 x T_4$	45.474	0.506	-1.380	-15.210	12.707**	-2.709	5.740**
$L_7 x T_1$	0.368	-9.164**	10.863**	-22.352	-20.420	-10.393	-2.428
$L_7 x T_2$	2.979	8.153	0.761	-24.194	-14.038	-6.491	-14.968
$L_7 x T_3$	-1.050	3.773	10.629**	-17.895	3.155	-9.206	-6.199
$L_7 x T_4$	32.891	-7.681**	7.465**	-19.741	9.960**	-9.365	-11.782
$L_8 x T_1$	-4.561	8.495	7.520**	-30.641	-1.970	-21.259	-4.532
$L_8 x T_2$	5.687	13.544	-4.314	-20.430	5.413	-16.770	-1.097
$L_8 x T_3$	1.749	5.765	8.473**	-14.035	29.845**	-16.617	2.463**
$L_8 x T_4$	35.011	3.275	0.003	-10.680	23.369**	-14.164	-6.344
$L_9 x T_1$	12.288	12.326	13.649**	-47.044	2.746	-7.923	-2.926
$L_9 x T_2$	2.076	16.812	9.898**	-39.785	14.182**	-13.138	7.948**
$L_9 x T_3$	1.765	10.868	14.200**	-26.316	-12.738	-9.206	5.982**
$L_9 x T_4$	35.231	10.284	13.617**	-35.599	-15.952	-15.402	-15.106

* and ** indicate significant at 0.05 and 0.01 %of probability, respectively

Table 3. Cont.

Character Genotype	Heading date	Plant height	Spike length	Number of spikes/ Plant	Number of ker-nels / Spike	1000-kernel weight	Grain yield / plant
$L_{10} \times T_1$	9.820	1.606	14.484**	-54.347	-14.216	-9.828	12.241**
$L_{10} \times T_2$	10.765	12.185	-5.076	-26.613	-10.646	-6.414	7.104**
$L_{10} \times T_3$	0.859	3.421	13.946**	-33.390	5.130	-9.805	17.758**
$L_{10} \times T_4$	29.933	-0.977	14.029**	-19.015	4.740	-7.120	12.084**
$L_{11} \times T_1$	-2.409	12.582	19.498**	-34.623	-0.096	-0.585	12.598**
$L_{11} \times T_2$	-13.005**	21.790	-7.614	-25.269	-8.011	-5.023	-3.751
$L_{11} \times T_3$	-3.472	20.396	6.140**	-20.351	-13.799	-9.056	2.734**
$L_{11} \times T_4$	14.172	10.968	4.087**	-19.094	-21.235	-6.269	6.344**
$L_{12} \times T_1$	-21.046**	6.290	20.501**	-39.137	2.297	1.107*	-1.855
$L_{12} \times T_2$	-19.225**	15.319	-2.791	-19.892	10.501**	1.931**	11.446**
$L_{12} \times T_3$	-21.473**	9.908	29.376**	-26.179	20.640**	-21.931	7.200**
$L_{12} \times T_4$	1.986	1.893	24.477**	-39.704	19.270**	0.003	0.004
$L_{13} \times T_1$	1.692	-1.148	3.252**	-30.968	-7.948	-9.546	-3.818
$L_{13} \times T_2$	3.182	0.853	-6.852	-30.645	-12.631	-11.901	-16.174
$L_{13} \times T_3$	4.740	0.065	-0.569	-26.316	-6.073	-9.356	-7.688
$L_{13} \times T_4$	25.872	-4.128**	-9.213	-25.243	-12.415	-12.307	-4.833
$L_{14} \times T_1$	-14.155**	15.855	11.699**	-55.399	-21.551	-9.687	17.059**
$L_{14} \times T_2$	-12.424**	22.650	-1.015	-30.855	-13.316	-3.400	-15.089
$L_{14} \times T_3$	-17.054**	16.798	5.188**	-40.617	-19.564	-5.913	-6.740
$L_{14} \times T_4$	7.108	15.213	2.459**	-39.303	-20.693	-6.965	0.755
$L_{15} \times T_1$	-2.199	11.011	11.977**	-39.666	-16.414	-7.288	1.713*
$L_{15} \times T_2$	-3.486	18.551	1.015	-29.839	-15.482	-0.386	-24.979
$L_{15} \times T_3$	-7.441*	16.685	10.644**	-28.421	-8.079	-7.035	-18.652
$L_{15} \times T_4$	21.766	11.646	7.277**	-22.330	-10.194	-5.108	-11.178
$L_{16} \times T_1$	-9.695**	12.522	1.392	-5.742	-28.304	-18.225	6.887**
$L_{16} \times T_2$	-6.736	16.319	-10.914	-8.333	-19.776	-20.325	-15.571
$L_{16} \times T_3$	-8.717*	14.932	5.128**	9.473**	1.978	-30.389	-14.185
$L_{16} \times T_4$	25.739	12.121	-0.854	11.003**	11.929**	-20.433	-5.136
$L_{17} \times T_1$	10.190	5.212	3.064**	25.511**	-16.155	-5.312	-8.458
$L_{17} \times T_2$	7.104	9.503	-6.852	-4.032	-6.640	-6.785	10.360**
$L_{17} \times T_3$	8.734	5.673	8.308**	8.070**	1.693	-7.410	18.570**
$L_{17} \times T_4$	32.406	2.446	10.149**	5.177**	-17.307	-6.811	-19.335
$L_{18} \times T_1$	19.317	2.154	3.342**	12.780**	-10.889	-22.247	0.999
$L_{18} \times T_2$	9.641	2.222	-7.106	0.537	-2.923	-20.556	-30.165
$L_{18} \times T_3$	10.755	3.569	0.890	-10.877	24.729**	-22.006	-18.381
$L_{18} \times T_4$	34.348	9.191	-2.985	-1.294	22.977**	-20.975	-28.852

* and ** indicate significant at 0.05 and 0.01% of probability, respectively

Table 3. Cont.

Character Genotype	Heading date	Plant height	Spike length	Number of spikes / plant	Number of kernels / spike	1000-kernel weight	Grain yield / plant
L_{19} x T_1	4.082	12.474	25.348**	-7.666	-6.365	-5.383	0.285
L_{19} x T_2	-2.200	14.483	-6.852	-15.054	-27.968	-1.777	-12.676
L_{19} x T_3	0.159	-8.801**	15.133**	-16.140	-20.381	-3.892	-2.680
L_{19} x T_4	25.783	2.425	15.820**	-13.916	-28.677	-5.185	-13.746
L_{20} x T_1	-8.593*	-16.717**	-10.306	23.445**	-30.759	-2.067	7.780**
L_{20} x T_2	-11.882**	4.498	1.522*	-19.086	-32.588	0.618	-1.700
L_{20} x T_3	-9.1977*	6.579	22.551**	-8.771	-12.482	-2.170	8.960**
L_{20} x T_4	15.187	7.452	22.686**	-8.414	-9.647	-2.167	9.214**
L_{21} x T_1	16.062	2.540	0.278	-5.952	-31.826	-8.417	-20.236
L_{21} x T_2	-5.671	1.571	-3.299	-18.280	-29.340	-1.545	-21.722
L_{21} x T_3	11.123	3.744	7.715**	-11.579	-34.656	-10.479	-15.539
L_{21} x T_4	28.167	6.318	11.343**	-9.061	-35.412	-3.870	-22.961
L_{22} x T_1	-1.570	4.702	4.178**	-1.773	-33.570	-5.524	12.776**
L_{22} x T_2	2.708	11.168	-8.883	-16.129	-32.479	-6.955	5.897**
L_{22} x T_3	-5.599	8.125	14.688**	-13.684	-12.400	-5.538	10.990**
L_{22} x T_4	27.064	6.061	13.432**	-4.530	-12.919	-7.043	-2.416
L_{23} x T_1	10.223	4.465	0.003	-36.402	-16.123	-7.006	7.601**
L_{23} x T_2	7.207	1.629	-18.020	-3.225	-8.913	-2.241	-15.330
L_{23} x T_3	28.241	5.573	6.231**	-17.895	2.025	-7.410	-5.793
L_{23} x T_4	20.132	8.788	20.597**	-10.356	-4.987	-2.167	-2.568
L_{24} x T_1	-14.657**	21.822	9.749**	5.351**	-25.913	-6.230	-10.778
L_{24} x T_2	3.046	11.866	-6.599	-13.441	-22.447	-0.154	-6.525
L_{24} x T_3	-8.176*	14.768	15.727**	-3.157	-7.758	-2.919	2.328**
L_{24} x T_4	26.181	16.825	8.656**	-3.883	-11.115	0.309	-9.516
L_{25} x T_1	13.062	14.245	18.384**	-30.701	1.615	3.224**	6.887**
L_{25} x T_2	1.228	1.063	4.060**	-1.612	12.811**	3.400**	-2.062
L_{25} x T_3	12.988	6.555	-4.273	-28.070	-32.833	5.913**	7.336**
L_{25} x T_4	20.551	4.783	-7.128	-19.885	-39.999	-0.464	-4.682
L_{26} x T_1	-19.287**	10.951	8.356**	2.338**	-18.998	-3.831	-0.428
L_{26} x T_2	-10.833**	27.973	-3.045	-7.795	-8.733	0.154	-22.808
L_{26} x T_3	-22.399**	13.412	-1.680	-3.157	-8.101	1.497**	-14.997
L_{26} x T_4	8.167	10.746	-2.016	-19.094	-6.643	-1.083	-7.855
L_{27} x T_1	-12.544**	7.839	3.064**	-4.306	-24.136	-12.227	24.018**
L_{27} x T_2	-6.574	9.176	-2.538	-26.613	-23.926	-9.196	9.878**
L_{27} x T_3	-13.326**	4.118	-3.163	-14.737	-9.702	-11.452	4.223**
L_{27} x T_4	17.483	2.384	-5.750	-16.505	-24.022	-11.223	6.797**

* and ** indicate significant at 0.05 and 0.01 %of probability, respectively

Table 3. Cont.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes/ Plant	Number of kernels /spike	1000-kernel weight	Grain yield / Plant
L_{28} x T_1	-10.706**	0.032	5.571**	31.418**	-16.607	-11.099	-29.910
L_{28} x T_2	-2.809	1.502	-10.406	-1.344	-19.621	-6.955	1.555
L_{28} x T_3	-5.122	-0.228	3.560**	12.280**	-23.107	-13.398	10.720**
L_{28} x T_4	34.878	2.576	-1.791	12.621**	-28.918	-13.777	0.755
L_{29} x T_1	4.746	5.428	5.013**	51.769**	-24.039	-1.009	-11.670
L_{29} x T_2	-17.468**	10.166	-11.168	8.333**	-16.637	6.414**	-20.637
L_{29} x T_3	-18.676**	5.082	8.308**	17.894**	-5.504	0.374	-21.359
L_{29} x T_4	20.794	3.008	12.537**	16.828**	-11.801	0.541	-18.278
L_{30} x T_1	5.835	2.508	1.671*	12.697**	-31.632	-7.641	-26.303
L_{30} x T_2	8.093	4.014	0.507	-3.225	-35.712	-1.081	-11.953
L_{30} x T_3	-0.104	-0.681	2.373**	3.508**	-22.336	-5.464	-3.627
L_{30} x T_4	17.483	-6.989**	6.865**	7.766**	-25.954	-6.888	5.891**
L_{31} x T_1	2.128	-8.141**	11.699**	-17.780	-33.893	-5.101	-4.354
L_{31} x T_2	1.015	-2.369	-6.345	1.075	-32.696	-0.154	-1.218
L_{31} x T_3	-8.378*	-3.103**	8.186**	-1.276	-21.667	0.074	1.922*
L_{31} x T_4	18.410	-12.713**	3.389**	9.708**	8.661**	-6.269	0.906
L_{32} x T_1	-1.519	7.358	16.991**	29.186**	5.234	-0.303	-12.384
L_{32} x T_2	-2.302	11.430	1.776*	-3.225	11.231**	7.650**	-8.816
L_{32} x T_3	-6.713	8.031	17.192**	10.526**	-32.582	3.443**	-4.845
L_{32} x T_4	26.092	-7.508**	11.982**	4.530**	28.311**	0.387	2.870**
L_{33} x T_1	-5.055	15.309	12.813**	-10.600	-4.103	2.166**	-33.262
L_{33} x T_2	2.945	20.799	1.269	-20.699	-18.982	8.964**	-1.459
L_{33} x T_3	-2.672	16.206	11.570**	-11.579	1.931	4.041**	2.328**
L_{33} x T_4	26.136	12.845	-3.033	-14.887	13.278**	-6.114	-5.891
L_{34} x T_1	-3.906	-4.968**	12.644**	-13.172	-16.607	-2.772	-0.527
L_{34} x T_2	3.486	-2.830*	-1.015	-16.667	-16.398	-2.395	-8.455
L_{34} x T_3	-1.940	-3.568**	7.983**	-8.421	-13.210	-8.682	-6.063
L_{34} x T_4	34.260	-11.057**	7.983**	-4.530	-34.002	-9.829	-6.948
L_{35} x T_1	-2.909	-18.187**	20.055**	42.583**	-7.883	-8.840	7.601**
L_{35} x T_2	-8.327*	-19.082**	3.553**	6.451**	-7.867	-3.920	-14.124
L_{35} x T_3	-15.296**	-9.984**	18.397**	8.070**	10.471**	-4.341	-5.116
L_{35} x T_4	24.989	-9.519**	11.044**	7.443**	-13.931	-0.345	0.004
L.S.D 5%	7.035	2.586	1.489	1.619	6.043	0.861	1.621
L.S.D 1%	9.225	3.391	1.953	2.123	7.923	1.130	2.126

* and ** indicate significant at 0.05 and 0.01% of probability, respectively.
Where: T_1, T_2, T_3 and T_4 denote tester 1 (Sids 4), tester 2 (Gemmeiza 9), tester 3 (Giza 168) and tester 4 (Sakha 93, respectively).

Table 4. Estimation of general combining ability (GCA) effects for heading date , yield and yield components.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes/ plant	Number of kernels/ spike	1000-kernel weight	Grain yield /plant
Line 1	-14.756**	-1.976**	1.790**	-0.058	9.509**	0.937**	1.587**
2	-0.381	-0.676	0.462	-1.008	-14.625	-0.354	-0.025
3	7.260	-1.735**	0.065	-2.866	9.524**	-2.146	-1.175
4	2.226	2.081	-0.484	-1.524	2.365**	-0.196	-0.742
5	0.476	0.214	0.632*	-2.041	8.365**	-1.754	-0.192
6	11.193	-0.627	0.098	-0.766	10.682**	0.979**	2.124**
7	7.110	-2.501**	0.240	-0.766	-2.050	-1.004	-1.108
8	8.360	6.073	-0.409	-0.299	17.415**	-4.737	0.449
9	5.168	2.673	0.848**	-2.316	10.040**	-2.079	0.882**
10	9.326	-0.876	0.215	-1.358	4.182**	-0.754	3.757**
11	-8.806**	5.581	-0.109	-1.058	5.365**	0.662**	1.782**
12	-17.054**	6.581	1.237**	-0.533	21.241**	0.854**	2.082**
13	5.668	0.206	-0.626	-1.549	-1.887	-1.821	-1.100
14	-10.223**	3.648	0.215	-1.399	-3.167	0.037	0.316
15	-0.689	2.006	0.440	-1.549	-1.925	0.720**	-2.475
16	-1.881	3.839	-0.776	1.700**	-5.759	-6.971	-0.975
17	6.885	-0.851	-0.451	1.766**	1.582	0.039	1.332**
18	10.226	3.023	-1.026	1.050**	8.424**	-6.596	-3.825
19	4.993	0.931	0.565*	0.066	-7.542	1.137**	-0.850
20	-7.798**	-0.468	0.173	0.400	-15.376	2.304**	2.241**
21	0.951	3.014	-0.401	0.166	-16.250	0.212	-3.773
22	3.118	3.425	-0.213	0.125	-15.200	0.179	2.482**
23	-0.248	7.048	-0.676	-0.141	-1.892	0.829**	-0.267
24	0.835	5.323	-0.076	0.658*	-8.517	1.912**	-0.400
25	-0.427	0.114	-0.217	0.575*	2.440*	4.312**	1.307**
26	-12.514**	-6.135**	-0.442	0.275	-4.300	2.570**	-3.817
27	-11.548**	-2.526**	-0.884	-0.666	-12.250	-1.962	3.374**
28	0.510	2.673	-0.959	2.250**	0.024	-2.079	0.374

Table 4. Cont.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes/ plant	Number of kernels/ spike	1000-kernel weight	Grain yield / plant
29	-5.381**	1.889	-0.467	3.100**	-5.384	3.629**	-3.358
30	1.002	-7.485**	-0.509	1.816**	6.934**	0.587**	0.831**
31	-1.456	-6.893**	-0.034	1.925**	-14.892	1.670**	0.816**
32	1.735	-6.676**	0.665*	1.783**	10.382**	4.170**	0.608*
33	4.468	3.589	-0.076	-0.283	0.874	3.970**	-0.900
34	5.660	-10.292**	0.482	0.191	0.404	0.345*	-1.358
35	-4.014**	-14.218**	0.707**	2.333**	1.265	0.395*	-0.001
L.S.D for line 5%	2.487	0.913	0.525	0.572	2.136	0.303	0.572
L.S.D for line 1%	3.261	1.197	0.688	0.750	2.801	0.398	0.750
L.S.D gi-gj 5%	3.516	1.291	0.744	0.809	3.020	0.431	0.809
L.S.D gi-gj 1%	4.610	1.693	0.976	1.061	3.960	0.565	1.061
Testers							
Sids 4 (1)	2.434	-1.432**	0.531*	-1.515	9.616**	1.983**	-3.836
Gemmeiza 9 (2)	-0.854*	3.442	0.047	1.525**	3.021**	-0.305	3.476**
Giza 168 (3)	1.248	0.371	-0.142	-0.356	-4.231	-0.202	1.822**
Sakha 93 (4)	-2.828**	-2.381**	-0.437	0.346**	-8.406	-1.475	-1.462
L.S.D for tester5%	0.840	0.307	0.176	0.192	0.721	0.101	0.192
L.S.D for tester1%	1.102	0.403	0.231	0.251	0.945	0.133	0.251
L.S.D gi-gj 5 %	1.187	0.437	0.250	0.272	1.021	0.145	0.272
L.S.D gi-gj 1 %	1.557	0.573	0.328	0.357	1.338	0.190	0.357

* and ** indicate significant at 0.05 and 0.01% of probability, respectively

Meantime, wheat lines 16, 17, 18, 24, 25, 28, 29, 30, 31, 32 and 35 showed desirable general combining ability effects for number of spikes / plant while lines number 1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 18, 25 and 32 for number of kernels /spike. Obviously, wheat lines no. 1, 6, 11, 12, 15, 19, 20, 23, 24, 25, 26, 29, 30, 31, 32, 33, 34 and 35 showed desirable general combining ability effects for 1000 kernel weight. Concerning grain yield /plant wheat lines no. 1, 6, 9, 10, 11, 12, 17, 20, 22, 25, 27, 30, 31 and 32 were good donors in this respect. The tester cultivar Sids 4 proved to be good general combiner for plant height, spike length, number of kernels /spike and 1000-kernel weight while the tester cultivar Gemmeiza 9 proved to be good general combiner for heading date, number of spikes / plant, number of kernels /spikes and grain yield/ plant .For grain yield / plant, significant positive general combining ability effects was detected for the tester cultivar Giza 168. Therein, tester cultivar Sakha 93 could be considered as an excellent parent in breeding programs towards releasing cultivars that are earlier in heading, shorter in height and higher in number of spikes / plant. However, it is apparent that the parent which possess high in GCA effects for grain yield /plant might be also for one or more traits contributing to yield, while the parent which had high GCA effects for one or more of yield components not necessarily had high GCA effects for yield itself.

b. Specific combining ability effects

Data presented in Table (5) showed that most hybrids exhibited significant and positive specific combining hybrids exhibited ability effects for yield and yield components traits, while for heading date and plant height,hybrids exhibited significant negative values. Twelve and thirty two out of 140 parental combinations exhibited significant negative effects for heading date and plant height .Earliness , if found, in wheat is favorable for escaping destructive injuries by stress conditions and for intensive production. Seven, five, twenty five, thirty eight and thirty three crosses had significant positive specific combining ability effects for spike length, number of spikes /plant, number of kernels /spike, 1000-kernel weight and grain yield / plant, respectively.

It could be concluded that the parental lines 1, 6, 11, 25, 30 and 32 might be selected as parental materials for wheat breeding programmes since the line no. 1 had the highest general combining ability effect for all studied traits except number of spikes / plant and it gave specific combining ability effect with the third tester Giza 168 (L_1 x T_3) for number of spikes/ plant, number of kernels / spike, 1000-kernel weight and grain yield / plant. In addition the line no. 6 was a good combiner for number of kernels / spike, 1000-kernel weight and grain yield / plant and also, exhibited high specific combining ability effect with the first tester sids 4 (L_6 x T_1) for heading date, spike length, number of kernels / spike, 1000-kernel weight and grain yield / plant. Moreover, the line 11 was a good donor for heading date, number of kernels / spike, 1000-kernel weight and grain yield / plant and it had relatively high specific combining ability effect with the tester sids 4 (L_{11} x T_1) for plant height, spike length, number of kernels / spike, 1000-kernel weight and grain yield /plant. Concerning the line no. 25 was a good combiner for number of

Table 5. Estimation of specific combining ability (SCA) effects for heading date, yield and yield components.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes/ plant	Number of kernels/ spike	1000-kernel weight	Grain yield / plant
$L_1 x T_1$	-0.409	-7.942**	0.168	-0.342	-0.960	-2.191	-2.101
$L_1 x T_2$	0.745	9.115	0.118	-0.250	-2.055	-1.136	2.286**
$L_1 x T_3$	-1.156	-0.346	-0.057	1.664**	5.014*	3.160**	1.140*
$L_1 x T_4$	0.820	-0.827	-0.229	-0.071	3.295	0.167	-1.325
$L_2 x T_1$	-1.184	-1.608	0.083	-0.559	-2.391	-2.166	-0.688
$L_2 x T_2$	1.770	7.749	0.213	0.899	-4.530	0.088	2.365**
$L_2 x T_3$	4.334	-0.412	0.003	-0.518	2.223	0.985*	0.686
$L_2 x T_4$	-4.921	-5.727**	-0.301	0.178	4.698**	1.092*	-2.362
$L_3 x T_1$	4.307	-1.783	0.493	1.165*	2.005	-1.574	2.061**
$L_3 x T_2$	-2.204	7.474	0.477	-1.108	-1.680	-0.386	-1.817
$L_3 x T_3$	-1.506	-3.221**	-0.432	-0.426	-1.593	1.310**	-1.330
$L_3 x T_4$	-0.596	-2.469**	-0.537	-0.629	0.248	0.650	1.087
$L_4 x T_1$	-23.759**	-0.533	-0.090	1.590**	-1.682	-0.924	-1.138
$L_4 x T_2$	8.995	0.490	0.327	-1.117	-2.488	-0.269	2.615**
$L_4 x T_3$	8.793	0.828	0.083	-0.301	1.431	0.627	0.369
$L_4 x T_4$	5.970	-0.785	-0.321	-0.171	2.740	0.567	-1.846
$L_5 x T_1$	-0.842	0.232	-0.040	-0.092	-6.382	-1.133	2.277**
$L_5 x T_2$	-0.187	-2.175**	0.210	-0.700	-2.121	-0.211	-0.734
$L_5 x T_3$	7.009	-0.171	-0.066	0.614	3.064	0.585	-2.313
$L_5 x T_4$	-5.979**	2.114	-0.104	0.178	6.440**	-1.399	0.770
$L_6 x T_1$	-9.726**	0.707	1.359*	-0.067	4.567*	0.759*	1.661**
$L_6 x T_2$	1.862	-10.534**	-0.856	-0.442	-0.938	0.188	0.248
$L_6 x T_3$	2.859	6.103	-0.066	0.139	0.721	0.352	-2.263
$L_6 x T_4$	3.289	3.722	-0.437	0.370	-9.643	0.859	0.353
$L_7 x T_1$	2.290	-6.417**	-0.215	0.098	-4.266	-0.183	1.394
$L_7 x T_2$	-1.320	5.840	0.235	-0.142	-0.371	0.105	-1.184
$L_7 x T_3$	1.156	4.578	0.025	0.139	0.481	0.102	0.069
$L_7 x T_4$	-0.412	-4.002**	-0.046	-0.096	4.156	-0.024	-0.279
$L_8 x T_1$	-0.559	2.141	0.034	-0.267	-4.699	-1.583	-1.097
$L_8 x T_2$	0.095	2.199	0.218	-0.142	-1.871	-0.594	1.090
$L_8 x T_3$	0.526	-2.329**	0.208	0.039	3.581	0.535	0.644
$L_8 x T_4$	-0.062	-2.010**	-0.462	0.370	2.990	1.642**	-0.637
$L_9 x T_1$	4.065	1.207	-0.490	-0.184	7.542**	2.058**	-1.230
$L_9 x T_2$	-2.479	0.432	0.827	-0.525	13.603**	-1.686	3.157**
$L_9 x T_3$	-4.881	-1.929**	-0.282	0.889	-11.310	1.177**	1.077
$L_9 x T_4$	3.295	0.289	-0.054	-0.179	-9.835	-1.549	-3.004

* and ** indicate significant at 0.05 and 0.01% of probability ,respectively

Table 5. Cont.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes plant	Number of kernels /spike	1000-kernel weight	Grain yield / plant
L_{10} x T_1	2.107	-0.908	0.243	-1.042	-4.099	-0.166	-1.272
L_{10} x T_2	4.129	4.315	-0.506	0.149	-3.471	-0.111	0.048
L_{10} x T_3	-1.373	-0.979	0.017	0.031	1.848	-0.414	1.102
L_{10} x T_4	-4.862	-2.427**	0.245	0.861	5.723**	0.692*	0.120
L_{11} x T_1	1.707	-2.067**	1.168*	-0.476	9.283**	2.783**	1.149*
L_{11} x T_2	-4.970**	1.424	-0.514	0.016	-2.221	-0.928	-0.976
L_{11} x T_3	1.893	3.228	-0.357	0.198	-2.268	-1.497	-0.622
L_{11} x T_4	1.370	-2.585**	-0.296	0.261	-4.793	-0.357	0.448
L_{12} x T_1	-1.074	-0.600	-0.058	0.465	-4.122	3.391**	-2.230
L_{12} x T_2	0.980	3.424	-1.227	0.157	-0.997	1.880**	2.923**
L_{12} x T_3	-0.325	1.162	0.728	0.839	1.022	-7.422	0.177
L_{12} x T_4	0.418	-3.985**	0.557	-1.463	4.097	2.150**	-0.871
L_{13} x T_1	-2.401	1.407	0.084	-0.084	7.567**	1.033**	0.586
L_{13} x T_2	0.320	-1.434	0.102	-0.158	-0.105	-1.411	-1.526
L_{13} x T_3	6.351	0.837	0.292	0.123	-3.451	0.852**	-0.305
L_{13} x T_4	-4.271	-0.810	-0.479	0.120	-4.010	-0.474	1.245*
L_{14} x T_1	2.290	-0.133	-0.090	-0.234	-4.316	-0.891	3.069**
L_{14} x T_2	0.845	0.990	0.027	-0.175	1.411	0.396	-2.642
L_{14} x T_3	-0.590	-1.104	0.051	0.473	-0.135	0.527	-1.488
L_{14} x T_4	-2.546	0.247	0.012	-0.063	3.040	-0.032	1.062
L_{15} x T_1	2.557	-1.658	-0.281	-0.284	-0.257	-0.441	2.994**
L_{15} x T_2	0.112	0.199	0.068	-0.058	-1.830	1.013**	-2.584
L_{15} x T_3	-1.656	1.603	0.158	-0.076	-0.210	-0.655	-1.630
L_{15} x T_4	-1.012	-0.144	0.053	0.420	2.298	0.084	1.220*
L_{16} x T_1	-1.084	0.107	-0.331	-0.234	-8.691	2.083**	2.461**
L_{16} x T_2	-1.895	-1.300	-0.281	-0.642	-1.963	0.105	-1.484
L_{16} x T_3	-0.198	0.503	0.508	0.273	3.356	-3.364	-2.030
L_{16} x T_4	3.178	0.689	0.103	0.603	7.298**	1.175**	1.053
L_{17} x T_1	0.148	0.966	-0.456	0.165	-3.499	1.173**	-2.713
L_{17} x T_2	0.470	0.124	-0.072	-0.175	2.828	-1.064	3.373**
L_{17} x T_3	-0.065	-0.404	0.051	0.073	5.914**	-0.140	3.727**
L_{17} x T_4	-0.554	-0.685	0.478	-0.063	-5.243	0.032	-4.387
L_{18} x T_1	5.140	-0.675	0.151	-0.084	-4.907	-0.191	4.211**
L_{18} x T_2	-0.837	-5.484**	0.468	1.107	-0.580	-0.369	-2.667
L_{18} x T_3	-1.873	-1.079	-0.207	-1.010	5.273*	-0.005	-0.213
L_{18} x T_4	-2.429	7.239	-0.412	-0.013	0.215	0.567	-1.329

* and ** indicate significant at 0.05 and 0.01% of probability ,respectively

Table 5. Cont.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes/ plant	Number of kernels/ spike	1000-kernel weight	Grain yield / plant
L_{19} x T_1	5.740	8.482	1.193*	0.698	15.725**	0.041	1.102
L_{19} x T_2	-4.304	5.540	-1.089	0.157	-7.746	-0.003	-0.809
L_{19} x T_3	2.226	-13.787**	-0.199	-0.526	-2.726	0.327	0.677
L_{19} x T_4	-3.662	-0.235	0.095	-0.329	-5.251	-0.365	-0.971
L_{20} x T_1	-0.334	-15.617**	-2.681	0.932	-1.607	0.441	-0.588
L_{20} x T_2	-1.045	0.574	0.402	-0.675	-4.180	-0.136	-0.867
L_{20} x T_3	0.251	5.712	1.025	-0.160	2.739	-0.072	0.452
L_{20} x T_4	1.128	9.331	1.253*	-0.096	3.048	-0.232	1.003
L_{21} x T_1	5.882	0.432	-0.840	0.465	-1.832	-0.466	0.152
L_{21} x T_2	-10.629**	-5.409**	0.343	-0.342	-0.305	1.021**	-0.426
L_{21} x T_3	2.568	-0.171	-0.066	-0.193	-0.685	-1.680	0.394
L_{21} x T_4	2.178	5. 147	0.562	0.070	2.823	1.125**	-0.121
L_{22} x T_1	0.348	-1.278	-0.560	-0.192	-4.682	0.933**	0.102
L_{22} x T_2	2.404	0.079	-0.576	-0.033	-4.255	-1.278	0.990
L_{22} x T_3	-1.931	0.218	0.529	-0.351	2.564	0.552	0.711
L_{22} x T_4	-0.821	0.980	0.607	0.578	6.373**	-0.207	-1.804
L_{23} x T_1	-4.851	0.999	-0.598	-1.592	0.008	-0.416	1.886**
L_{23} x T_2	-4.129	-6.775**	-1.314	1.832**	4.203	0.105	-2.126
L_{23} x T_3	11.668	0.328	0.042	-0.485	-0.476	-0.930	-0.672
L_{23} x T_4	-2.687	5.447	1.870**	0.245	-3.735	1.242**	0.912
L_{24} x T_1	-3.467	6.424	-0.031	0.007	-3.466	-1.133	-1.413
L_{24} x T_2	5.020	- 7.434**	-0.414	-0.233	-1.671	-0.078	0.440
L_{24} x T_3	-2.348	-1.779	0.508	0.114	1.714	-0.014	1.461*
L_{24} x T_4	0.795	2.839	-0.062	0.112	3.423	1.225**	-0.487
L_{25} x T_1	2.794	8.566	1.143*	0.057	13.975**	0.933**	1.477*
L_{25} x T_2	-4.516	-8.709**	1.127*	1.316*	19.936**	-0.944	-0.034
L_{25} x T_3	3.913	-0.471	-1.082	-0.801	-15.776	1.519**	0.986
L_{25} x T_4	-2.191	0.614	-1.187	-0.571	-18.135	-1.507	-1.129
L_{26} x T_1	-1.351	-2.483**	0.168	-0.276	-0.549	-0.658	2.136**
L_{26} x T_2	4.704	6.474	0.418	0.849	6.778**	-0.603	-2.442
L_{26} x T_3	-3.898	-2.287*	-0.424	0.498	-5.235	1.294**	-1.188
L_{26} x T_4	0.545	-1.702	-0.162	-1.071	-0.993	-0.032	1.495*
L_{27} x T_1	-5.317*	3.241	-0.023	0.065	2.100	-0.091	0.311
L_{27} x T_2	3.570	-0.401	0.927	-0.542	0.694	-0.103	1.198**
L_{27} x T_3	-4.865	-1.996**	-0.449	0.339	1.581	0.060	-1.847
L_{27} x T_4	6.612	-0.844	-0.454	0.136	-4.376	0.134	-0.662

* and ** indicate significant at 0.05 and 0.01% of probability, respectively

Table 5. Cont.

Character / Genotype	Heading date	Plant height	Spike length	Number of spikes/ plant	Number of kernels/ spike	1000-kernel weight	Grain yield /plant
L_{28} x T_1	-8.442**	0.641	0.351	0.115	-2.407	0.558	-5.954
L_{28} x T_2	-0.420	-2.734**	-0.031	-0.325	-1.146	0.980**	1.898**
L_{28} x T_3	1.176	-1.429	0.025	-0.010	2.606	-0.689	2.752**
L_{28} x T_4	7.687	3.522	-0.346	0.220	0.948	-0.849	1.003
L_{29} x T_1	13.148	0.957	-0.206	0.498	-4.666	-0.383	1.377*
L_{29} x T_2	-8.962**	0.649	-0.622	0.024	0.561	1.038**	-0.501
L_{29} x T_3	-7.131**	-1.179	0.067	-0.326	2.348	-4.264	-1.413
L_{29} x T_4	2.945	-0.427	0.762	-0.196	1.756	-0.390	0.537
L_{30} x T_1	1.665	4.032	-0.565	0.382	-10.949	0.075	-3.697
L_{30} x T_2	7.120	0.557	0.952	-0.125	-10.321	0.846**	-0.442
L_{30} x T_3	-2.848	-0.737	-0.557	-0.410	10.364**	0.177	0.611
L_{30} x T_4	-5.937*	-3.852**	0.170	0.153	10.906**	0.691**	3.528**
L_{31} x T_1	3.323	-0.125	0.159	-0.559	-5.324	-0.358	-1.430
L_{31} x T_2	5.312	0.765	-0.422	0.299	-4.763	0.163	0.690
L_{31} x T_3	-5.856*	3.103	0.233	0.014	-4.243	1.560**	0.144
L_{31} x T_4	-2.779	-3.744 **	0.028	0.245	14.331**	-1. 365	0.595
L_{32} x T_1	3.032	3.691	0.093	-0.051	9.767**	-0.591	-1.722
L_{32} x T_2	-1.145	2.449	-0.056	-0. 092	18.061**	1.030**	-0.201
L_{32} x T_3	-1.715	2.487	0.133	0.289	-18.118	0.560	-0.313
L_{32} x T_4	-0.171	-8.627**	-0.171	-0.146	-9.710	2.066**	2.237**
L_{33} x T_1	1.798	0.557	0.334	0.015	9.642**	0.775*	-5.113
L_{33} x T_2	1.287	0.582	0.618	-0.192	-7.863	1.796**	2.340**
L_{33} x T_3	-0.215	-0.446	-0.491	0.256	-3.310	1.02 7**	1.961**
L_{33} x T_4	-2.871	-0.694	-0.462	-0.079	1.531	-3.599	0.812
L_{34} x T_1	-2.059	2.040	-0.090	-0.496	-2.787	-1.691	0.744
L_{34} x T_2	0.629	-0.798	-0.239	-0.167	-0.606	0.521	-0.134
L_{34} x T_3	-0.640	1.569	0.017	0.081	9.759**	-1.014	-0.647
L_{34} x T_4	2.070	-2.811**	0.312	0.511	-6.365	-1.574	0.037
L_{35} x T_1	3.915	-3.001**	0.418	0.332	5.350*	-0.849	1.619**
L_{35} x T_2	-1.329	-8.209**	0.135	0.557	2.011	0.038	-2.059
L_{35} x T_3	-7.331**	3.995	0.025	-0.493	2.931	0.869**	-0.772
L_{35} x T_4	4.745	7.214	-0.573	-0.396	-10.293	-4.421	1.212*
L.S.D SCA5%	4.974	1.828	1.052	1.144	4.272	0.610	1.146
L.S.D SCA1%	6.522	2.397	1.380	1.501	5.602	0.800	1.503
L.S.D Sij-Sik 5%	7.034	2.585	1.489	1.618	6.042	0.862	1.620
L.S.D Sij-Sik 1%	9.223	3.389	1.953	2.122	7.923	1.131	2.125

* and ** indicate significant at 0.05 and 0.01% of probability, respectively

spikes / plant, number of kernels / spike, 1000-kernel weight and grain yield / plant and it had relatively high specific combining ability effect with the first tester sids 4 (L_{25} xT_1) for spike length, number of kernels / spike 1000-kernel weight and grain yield /plant. Moreover, the line no. 30 was good donor for plant height, number of spikes / plant, number of kernels /spike, 1000-kernel weight and grain yield /plant and also exhibited high specific combining ability effect with the fourth tester Sakha 93 (L_{30} xT_4) for heading date, plant height, number of kernels / spike 1000-kernel weight and grain yield / plant. In addition the line no. 32 was a good combiner for all traits studied except heading date and also exhibited high specific combining ability values with the fourth tester Sakha 93 (L_{32} x T_4) was a good donor for plant height, 1000-kernel weight and grain yield / plant. These parents may be used in suitable selection programmes where they possess high amount of additive genetic variance. It could be noticed that these hybrids were the favorable crosses for grain yield via some components of yield such as number of spikes / plant, number of kernels / spik and 1000-kernel weight. These combinations expressed significant heterotic effects relative to better parents.

The results obtained herein concerning general and specific combining ability effects could indicate that excellent hybrids combinations were obtained from the three possible combinations between the parents of high and low general combining effects i.e. high x high, high x low and low x low consequently it could be concluded that general combining ability effects of the parental lines were generally unrelated to the specific combining ability effects of their respective crosses.

4. Gene effects

The estimates of additive, non additive, degree of dominance and heritabilities in broad and narrow senses with respect all studied traits are presented in Table (6). The results revealed that the additive gene effects were larger than those of the non additive variance $(\delta^2 D/\delta^2 A)^{1/2}$ for heading date, plant height, spike length, number of spikes / plant, number of kernels / spike, 1000- kernel weight and grain yield / plant. These could be verified by the ratio which were less than one, revealing the importance of partial dominance and that additive effects played the major role in the inheritance of these traits. Many authors suggested that, additive genetic variance and GCA variance were important for these traits such as **Salem and El-Banna (1982); Salem and Hassan (1991); Singh *et al* (1994); Rajara & Maheshwari (1996) and El-Hosary *et al* (2000).**

Concerning heritability, it is likely to mention that broad sense heritability (T_b%) was high and exceeded 74% for all traits studied and moderate for spike length (48.606%). However narraw sense heritability was high (more than 50%) for plant height, number of spikes / plant, number of kernels / spike, 1000- kernel weight and grain yield / plant and moderate (30-50%) for heading date and spike length. These results suggest that all traits are highly heritable, so that rapid gain from selection for earliness as well as grain yield and its components would be possible through segregating generations. Similar results were obtained by

Table 6. Genetic Parameters of studied agronomic characters.

Parameters / Characters	$\delta^2 A$	$\delta^2 D$	$\delta^2 e$	$T_b\%$	$T_n\%$	GS.	GS%	$(\delta^2 D/\delta^2 A)^{1/2}$
Heading date	35.418	20.622	19.328	74.355	46.992	8.403	8.711	0.763
Plant height	28.571	21.415	2.612	95.033	54.318	8.114	8.096	0.865
Spike length	0.669	0.150	0.866	48.606	39.692	1.06	8.340	0.473
Number of spikes / plant	6.614	0.025	1.024	86.635	86.309	4.921	56.028	0.061
Number of kernels /spike	251.148	47.879	14.259	95.448	80.165	29.228	37.090	0.436
1000-kernel weight	9.782	2.132	0.291	97.616	80.145	5.766	13.881	0.466
Grain yield /plant	39.122	3.880	1.027	97.666	88.852	12.144	54.415	0.314

Where : $\delta^2 A$, $\delta^2 D$, $\delta^2 e$, $T_b\%$, $T_n\%$, Gs and Gs% denote, Additive, Dominance ,environmental variance,broad sense heritability,narrow sense heritability,expected advance as mean value and as % of means.

Hamada (1988); El-Marakby *et al* (1993); Hamada *et al* (1997) and Hamada & Tawfelis (2001).

Considering the expected genetic advance under 5% selection intensity, the results showed that the highest expected gain (expressed as a percentage of the mean) was reported for number of spikes/ plant (56.028%), grain yield / plant (54.415%) number of kernels / spike (37.09%) and 1000- kernel weight (13.881%) followed by heading date (8.711%), spike length (8.34%) and then plant height (8.096%). Similar trend was detected by **Salem and El-Banna (1982); Salem and Hassan (1991); Bijendra *et al* (1992)** and **Singh *et al* (1994).**

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معايير التربية لتاريخ الطرد والمحصول ومكوناته في القمح باستخدام تحليل السلالة × الكشاف

[٣٨]

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أجريت هذه الدراسة بمحطة البحوث الزراعية بالجميزة خلال الموسمين الشتويين ٢٠٠٠/٢٠٠١، ٢٠٠١/٢٠٠٢ وذلك بغرض دراسة قوة الهجين والقدرة على التالف والفعل الجينى المتحكم لصفات تاريخ الطرد وطول النبات وطول السنبلة وعدد السنابل للنبات وعدد حبوب السنبلة ووزن ألف حبة ومحصول الحبوب للنبات. استخدم فى هذه الدراسة خمسة وثلاثون سلالة مستوردة من القمح تم تهجينها مع أربعة أصناف مصرية وهى سدس ٤ ، جميزة ٩ ، جيزة ١٦٨ ، سخا ٩٣ ونتج ١٤٠ هجينا قميا بنظام التزاوج القمى وكانت اهم النتائج المتحصل عليها كمايلى:

أظهرت النتائج معنوية عالية فى تحليل التباين فى كل الصفات المدروسة لكل من

التراكيب الوراثية ، الأبـــاء ، الأبـــاء مـــع الهجـــن ، والسلالات والكشاف والســـلالات مع الكشاف فيما عدا صفة طـــول الســـنبلة وعدد السنابل للنبات وذلك للســـلالات مـــع الكشاف للسلالات مع الكشاف.

أوضحت النتائج الدور المهم لكـــل مـــن تأثير الفعل الجينى المضيف والفعل الجينـــى الغير مضيف لجميع الصفات تحت الدراســـة حيث تفوق الفعل الجينـــى المضيـــف علـــى الفعل الجينى الغير مضيف لجميع الصفـــات فيما عدا تاريخ الطرد وطول النبات .

كانت السلالات رقـــم ١، ٦، ١١، ٢٥، ٣٠ ، ٣٢ ، افضل السلالات للاستخدام فـــى برامج التربية لقدرتها العالية على الائتـــلاف لصفات المحصول ومكوناته وكانت الـــهجن $L_{30} \times T_4$، $L_{32} \times T_4$ أفضل الهجن فـــى إظهار قوة الهجين بالنسبة لـــلأب الأفضـــل وقدرتها الخاصة على الائتلاف للمحصـــول ومكوناته.

كانت قيم معامل التوريث بالمعنى العـــام اكثر من ٧٠% لجميع الصفات المدروســـة وكانت متوسطة لصفة طول السنبلة بينمـــا كانت كفاءة التوريث بالمعنى الخاص عاليـــة لجميع الصفات المدروسة ومتوسطة لصفـــة تاريخ الطرد وطول السنبلة وكـــان مقـــدار التحسين المتوقع عاليا لصفة عدد الســـنابل للنبات (٥٦,٠٢%) يليها محصول الحبـــوب للنبـــات (٥٤,٤١%) ، وعـــدد حبـــوب الســـنبلة(٣٧,٠٩%)، ووزن الـــف حبـــة (١٣,٨٨%) ، تـــاريخ الطـــرد (٨,٧١%) ، وطول السنبلة(٨,٣٤%) ثم طـــول النبـــات (٨,٠٩%).

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