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ESTIMATION OF COMBINING ABILITY FOR YIELD AND ITS COMPONENTS IN BREAD WHEAT USING LINE X TESTER ANALYSIS

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ABSTRACT

Twelve bread wheat genotypes were evaluated at EL-Gemmeiza Agriculture Research Station during two successive seasons 2004/2005 and 2005/2006 to study general and specific combining ability for some quantitative characters in bread wheat . These genotypes and cultivars were crossed with three local wheat cultivars Gemmeiza 7 , Giza 168 and Gemmeiza 10 to produce thirty six crosses using Line x tester analysis . The traits studied were heading date , plant height , spike length , number of spikes/plant , spike weight ,number of kernels / spike , 1000- grain weight and grain yield / plant .

The genotypes (parents and crosses) exhibited highly significant variation for all traits studied indicating the presence of genotypic differences among these fifteen genotypes under investigation. The mean square of parent vs crosses were found to be highly significant for all traits studied expect spike length and spike weight which expected only significant. Further partitioning of crosses mean squares i.e., Line x tester analysis showed highly significant for all traits studied. The G.C.A. / S.C.A. ratio exceeded the unity for most traits studied expect heading date and spike length indicating that additive variance was predominantly controlling the inheritance of these traits .The parental lines 1,11 and tester Gemmeiza 10 might be selected as parental materials for wheat breeding programmes . The line number one had highest general combining ability effects for number of spikes/plant, spike length and 1000-grain weight. The lines and testers which performed good combining ability effects for grain yield were also good combiners for at the least one of the three yield components.
Keywords: - Wheat genotypes, Line x Tester , G.C.A. , S.C.A

INTRODUCTION

The common bread wheat *(Triticum aestivum L.)* is one of the major crops which widely grown not only Egypt but also through out the world as prime food cereal .Increasing wheat production to narrowing the gap between production and consumption is considered one of the main goal of wheat breeders as well as in most countries all over the world , Shehab EL-Din, (1993).

Combination ability analysis has been used extensively in cross pollinated crops classify the parental lines in terms of their ability to combine hybrid combination. In self pollinated crops like wheat, combining ability analysis could be useful which give an good idea about the relative magnitude of additive and non additive type of gene action in expression a trait. Moreover, it seems of special interest of the some commercial cultivars .deposit of being the best in their agronomic characters, yet they combine very poorly when used as parents. Therefore, this will be helpful in choosing parents in hybridization program and to breed desirable characters.

General and specific combing ability estimates has been made several wheat workers (Brown *et al*, 1966 ; Mani and Roa,1977; Singh *et* *al*,1982 ; Bhuller *et al*, 1988 and Abd El-Rahman 1991) .These studies, in general , indicated that the large part of the total genetic variation for yield was associated with general combing ability effects , which measure additive genetics variance when the parents are randomly chosen . On other hand, specific combing ability measures non-additives genetics variance.

The concept of combining ability is becoming increasingly important in plant breeding .It is especially useful in connection with testing procedures, in which it is designed to study and compare the performance of lines in hybrid combinations . It seems that some commercial cultivars despite of being the best in their agronomic characters , yet they are low combines when used as parents . for that , it is often desirable to select lines as parents of crosses . The Line x tester analysis was used to estimate both general and specific combining ability effects for yield and its components in wheat by several authors such as Hassan and Abd EL-Moniem (1991); Salem and Hassan (1991) ; Singh et al (1994) ;Gupta and Ahmed (1995) ; Hamada *et al* (2002) and Seleem and EL-Sawi (2006) . Most studies on wheat revealed that general combining ability (G.C.A.) was found to be more important than specific combining ability (S.C.A.) for number of spikes/plant (AL-Kaddossi and Hassan 1991) and Eissa (1993) . However (G.C.A.) and non-additive (S.C.A.) , genes effects were observed for grain yield / plant , number of kernels / spike , 1000- kernel weight and number of tillers/plant , (Saadalla and Hamada 1994) . and Chowdhry *et al* (1996) .On the other hand, EL-Beially and EL-Sayed (2002) concluded that mean square associated with (G.C.A.) and (S.C.A.) were significant for heading date , plant height , number of spikes/plant , number of kernels / spike , 1000-kernel weight and grain yield . So Line x tester analysis is used here in order to evaluate twelve parents along with three testers for general and specific combining ability.

MATERIALS AND METHODS

The present investigation was carried out at EL-Gemmeiza Agriculture Research Station during two successive winter seasons 2004/2005 and 2005/2006 to estimate some breeding parameters in bread wheat for grain yield and its contributing characters using Line x tester analysis . In 2004/2005 season, twelve bread wheat genotypes were crossed with three local wheat cultivars , Gemmeiza 7 , Giza 168 and Gemmeiza 10 as a testers "T" to produce sixty three crosses . The pedigree of the parental genotypes are presented in Table (1) . In 2005/2006 season , the thirty six F_1 crosses and their parental 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. apart and plants were spaced at 10 cm. within row for each studied genotype . The recommend agricultural practices were applied at the proper time . Data were recorded on 10 individual guarded plants from each parental genotypes and their resultant F_1 's for the following characters : heading date , plant height , spike length , ear yield , number of spikes / plant , number of kernels / spike , 1000- kernel weight and grain yield / plant .

Table (1) : Name and pedigree of the parental genotypes .

Genotypes	Pedigree	Origin
Gemmeiza 9	Ald (s) / Huac(s) // CMH 74A.630 /SX	Egypt
Giza 170	Kauz // Altra 84 / Aos	Egypt
Sakha 61	INIA / RL 4220 7C / Yr'R	Egypt
Sakha 93	Sakha 92 / TR 810328	Egypt
Milan	V5 73.600/MRL/3/BOW//YR/TRF	Mexico
Line (1)	BL 1133 /3/ CMH79A-955*2/CNO79// CMH79A.955 / BOW's'	Egypt
Line (2)	Seri 82 /4/SPN//MCD /CAMA/3/NZR	Mexico
Line (3)	PFAU / Milan	ICARDA
Line (4)	Prl's'/toni//Attila	Egypt
Line (5)	MAYA's'/Mon's'/4/CMH 72428/MRC//Jup/3/ 582 /A2 Sakha 8 /6/ Sakha 69	Egypt
Line (6)	Vee 's'/ Swm 6525 /4/Trm //Kal /Bb/3/Crow "s' /Piy "s'	Egypt
Chil's'	BTY / JUP	Mexico
Testers 'T'		
Gemmeiza 7	CMH 74A.630 /SX// Seri 82 / Agent	Egypt
Giza 168	Giza 156/7cMiL/BuC//seri	Egypt
Gemmeiza 10	Maya 74"s" /ON// 1160-1473/BB/Gll /4/ CHAT "s" /5/Crow "s"	Egypt

The obtained data were subjected to study combining analysis using the procedure of Line x tester analysis as outlined by Kempthorne (1957) .General and specific combining ability variances were estimated as described by Mather and Jinkes (1982).

RESULTS AND DISCUSSION

The analysis of variance for all traits studied are presented in Table (2) . Genotypes (15 parents and 36 crosses) exhibited highly significant variation for all traits studied indicating the presence of genetic differences among these fifteen genotypes under investigation . The mean square of parents vs crosses as an indication to the average heterosis over all crosses were found to be highly significant for all traits studied expect spike length and spike weight which were found to be significant . Further more partitioning of crosses mean squares into Line x tester analysis indicated that difference due to each lines and testers were highly significant for all traits studied expect ; spike weight and 1000-kernel weight for the lines and number of spikes / plant for both lines and testers which not reached to significant levels . The G.C.A. / S.C.A. ratio exceeded than unity for most traits studied expect heading date and spike length indicating that additive variance was predominantly controlling the inheritance of these traits . On the other hand , this ratio was less than unity for heading date and spike length indicating that S.C.A. variance was more important than G.C.A. variance and non additive genetic variance was the predominant variance components controlling the inheritance of these both traits . Similar results were previously reported by AL-Kaddossi *et al* (1994), Koumber (2001) , Hamada *et al* (2002) and koumber and EL-Beially (2005) .

Table (2):Analysis of variance for heading date, yield and yield components in bread wheat .

Source of variance	d.f.	Heading date	Plant height	Spike length	number of spikes / plant	Spike weight	number of kernels / spike	1000 – kernel weight	Grain yield
Replications	2	1.125	7.938	0.389	2.535	0.073	31.938	0.422	26.641
Genotypes	50	66.765**	238.708**	2.474**	10.144**	0.639**	133.546**	88.269**	106.015**
Parents	14	152.635**	248.078**	3.874**	3.9411**	0.842**	121.844**	81.639**	54.737**
Crosses	35	24.640**	209.348**	1.951**	12.493**	0.571**	132.162**	88.044**	127.081**
Parent vs crosses	11	163.938**	1135.146**	1.212*	14.759**	0.197*	345.833**	188.766**	86.631**
Lines	11	71.239**	434.966**	2.461**	12.532	0.632	79.557**	63.729	213.638**
Testers	2	47.688**	862.875**	15.922**	32.246	1.640**	670.469**	804.453**	469.980**
Lines x testers	22	7.201**	37.127**	0.426**	10.928**	0.443**	109.527**	35.073**	52.629**
Error	100	1.496	4.029	0.185	1.715	0.039	6.704	3.821	5.518
GCA		1.201	20.010	0.051	6.322	0.210	39.155	13.505	18.321
SCA		1.902	11.033	0.080	3.071	0.135	34.275	10.417	15.704
GCA / SCA		0.631	1.814	0.638	2.059	1.556	1.141	1.296	1.167

*** and ** indicate significant at $P \leq 0.01$ and $P \leq 0.05$, respectively.**

GCA/ SCA is an estimate of the ratio of additive to non-additive gene effects.

The concept of combining ability has become increasingly important in plant breeding .It is especially useful to study and compare between the performance of line in hybrid combination . Combining ability has been proved by many workers to be an inherited character . moreover , it looks to be of special interest in away that some commercial cultivars , deposit of being the best in their agronomic char haters , yet they are low in combiners when used as a parenters . Mean while, because of difficulties caused by correlation of genes in the parents , genetic interpretation of statistics may be attempted only that such information is useful in measuring hybrid performance or in assessing potentialities of hybrid breeding program . (Backer,1978) .

General combining ability (G.C.A.) :-

For twelve lines and three testers are presented in Table (3) . High positive values would be of interest in most traits under investigation . On the contrary , for heading date and plant height high negative values would be useful from the breeder point of view . For heading date , the five wheat lines 3,4,5,9 and 11 in addition to the tester Gem. 10 showed highly significant negative general combining ability effects revealing that these parental lines may be considered as a good combiners for developing early genotypes .

Also, six wheat lines 2,4,7,9,10,12 and tester Gemmeiza 10 exhibited highly significant negative estimates of general combining ability effects for plant height . These genotype may be take in consideration when selection to lodging .

On the other hand, wheat lines number 1,5,6 and tester Gemmeiza 7 gave positive general combining ability effects for spike length . Concerning number of spikes per plant parental lines 2,4,11 and tester Gemmeiza 10 showed highly significant G.C.A. effects proving to be good combiners in this respect . For spike weight five wheat lines 1,4,5,8,11 and tester Gemmeiza 7 showed significant values of general combining ability effects . Wheat lines number 3,8 and two testers Gemmeiza 7 and Gemmeiza 10 showed desirable general combining ability effects for number of kernels / spike while lines 1,5,6 , 8,9 and 11 in addition to two testers Gem. 7 and Giza 168 for 1000 – kernels weight . Concerning grain yield / plant, wheat lines number 1,2,3,4,11 and two testers cultivars Gemmeiza 7 and Gemmeiza 10 were considered as a good donors in this respect .

(3) : Estimation of general combining ability (G.C.A.) effects for heading date , yield and yield components .

Parents	Heading date	Plant height	Spike length	number of spikes / plant	Spike weight	number of kernels / spike	1000 – kernel weight	Grain yield
Lines 1	1.975**	3.492**	0.541**	0.634	0.230**	-0.394	1.703*	5.151**
2	1.875**	-2.640**	-0.145	1.98*	-0.090	0.089	-3.564**	2.228**
3	-2.736**	-0.315	-0.200	0.649	-0.020	2.402**	-1.442*	6.130**
4	-2.736**	-2.955**	0.182	1.434**	0.133*	-2.639**	-2.619**	6.171**
5	-2.647**	9.993**	1.295**	-1.669**	0.437**	1.963*	1.458*	-5.546**
6	3.553**	3.385**	0.326*	-1.803**	0.007	-5.711**	3.514**	-3.966**
7	1.953**	-10.638**	-0.606**	-1.252**	-0.254**	-1.124	-3.153**	-6.538**
8	2.086**	2.159**	-0.378**	-1.153**	0.206**	6.119**	2.569**	-2.107**
9	-2.847**	-1.722*	-0.031	0.755	-0.224**	-2.659**	3.647**	-0.405
10	0.231	-7.621**	-0.438**	-0.131	-0.280**	-0.167	-2.297**	-6.385**
11	-4.125**	13.175**	-0.141	0.902*	0.286**	1.499	1.458*	4.261**
12	3.419**	-6.314**	-0.377**	0.537	-0.430**	0.532	-1.275	1.026
L.S.D for G.C.A. line 5 %	0.808	1.325	0.285	0.865	0.129	1.709	1.291	1.550
L.S.D for G.C.A line 1%	1.068	1.751	0.377	1.144	0.170	2.258	1.706	2.049
Testers :								
Testers (1) Gemmeiza 7	-0.231	4.871**	0.754**	0.180	0.228**	2.104**	3.797**	2.760**
Testers (2) Giza 168	1.247**	0.049	-0.250**	-1.024**	-0.032	-4.694**	1.497**	-4.089**
Testers(3) Gemmeiza 10	-1.017**	-4.921**	-0.504**	0.843**	-0.195**	2.860**	-5.294**	1.329**
L.S.D for G.C.A. testers 5 %	0.404	0.663	0.143	0.432	0.065	0.855	0.645	0.776
L.S.D for G.C.A. testers 1 %	0.534	0.877	0.188	0.571	0.086	1.305	0.853	1.026

*** and ** indicate significant at $P \leq 0.01$ and $P \leq 0.05$, respectively.**

In general , general combing ability effects computed herein were found to be deviated significantly zero in most cases. High positives values would be of interest in the most traits .On the contrary ,for plant height , high negative values may be useful from the breeder's point of view . Restance to lodging is particularly important in the view of the desire to exploit yield promoting factor such as nitrogen fertilization or irrigation . Reduced lodging has usually been observed to be associated with decrease in culms length and consequently , the search for suitable genetic variation and the incorporation of sources of short stiff straw into breeding program have received much attention . (pinthus, 1973, Hendawy,1994 and Stance *et al* 1979) .

Specific combining ability : -

Results for specific combining ability effects of the studied characters are presented in Table (4) .Highly significant negative specific combining ability effects for heading date were detected in the two crosses $L_2 \times T_1$ and $L_6 \times T_2$ while three crosses showed that highly significant negative $L_2 \times T_3$, $L_4 \times T_3$ and $L_{10} \times T_2$ for plant height . As for number of spikes / plant $L_3 \times T_2$ and $L_5 \times T_1$ were found to be highly significant positive specific combining ability effects .

Table (4) : Estimation of specific combining ability (S.C.A.) effects for heading date , yield and yield components .

Crosses	Heading date	Plant height	Spike length	number of spikes / plant	Spike weight	number of kernels / spike	1000 – kernel weight	Grain yield
L_1 x T_1	-0.436	-2.035	0.120	-1.624*	0.367**	9.769**	-2.653*	-4.213**
T_2	-0.047	-1.489	0.316	1.394	-0.146	-1.996	1.047	0.637
T_3	0.483	3.524**	-0.436	0.230	-0.220	-7.773**	1.606	3.575**
L_2 x T_1	-2.303**	-1.473	0.042	1.038	0.593**	6.294**	3.981**	1.644
T_2	1.453*	9.186**	0.539*	0.379	0.110	-3.351*	-0.419	1.017
T_3	0.850	-7.714**	-0.580*	-1.418	-0.704**	-2.942	-3.561**	-2.661
L_3 x T_1	-0.592	3.592**	-0.273	-3.106**	-0.090	1.120	-1.642	-6.808**
T_2	1.197	-2.606*	-0.042	2.398**	-0.090	-2.678	2.225	2.888*
T_3	-0.606	-0.986	0.315	0.708	0.180	1.558	-0.583	3.920**
L_4 x T_1	-0.192	1.319	0.162	0.643	0.520**	-5.605**	2.036	0.747
T_2	0.797	1.924	-0.225	-1.660*	-0.276*	1.593	-0.931	-2.456
T_3	-0.606	-3.243**	0.063	1.017	-0.244*	4.012**	-1.106	1.709
L_5 x T_1	1.853**	0.801	-0.062	3.582**	0.100	-1.821	0.792	3.534*
T_2	0.308	-1.107	-0.098	-0.991	-0.150	-3.486*	-0.308	-2.056
T_3	-2.161**	0.306	0.160	-2.591**	0.050	5.307**	-0.483	-1.478
L_6 x T_1	1.319	0.649	-0.356	1.853*	-0.144	1.450	0.936	4.821**
T_2	-1.958**	-1.096	0.118	0.250	0.066	1.905	-2.597*	-0.176
T_3	0.639	0.447	0.238	-2.103**	0.079	-3.355*	1.661	-4.645**
L_7 x T_1	-0.747	0.539	0.316	-1.722*	-0.132	-2.714	-1.331	-5.000**
T_2	-0.025	-1.576	-0.647*	0.033	-0.099	-1.909	2.756*	-0.851
T_3	0.772	1.037	0.331	1.689*	0.231*	4.624**	-1.406	5.851**
L_8 x T_1	-0.547	0.142	0.208	-0.057	0.021	-9.490**	0.247	1.992
T_2	-1.425*	0.954	0.352	0.234	-0.252*	3.965**	1.214	-1.848
T_3	1.972**	-1.096	-0.560*	-0.177	0.231	5.525**	-1.461	-0.144
L_9 x T_1	-1.514*	0.406	-0.265	0.962	-0.282*	4.008**	-1.531	4.326**
T_2	1.408*	-1.098	0.082	-2.641**	0.195	2.876	0.303	-3.371*
T_3	0.106	0.692	0.183	1.679*	0.087	-6.884**	1.228	-0.956
L_{10} x T_1	-0.858	0.452	-0.025	-2.073**	-0.913**	-7.758**	-3.253**	-5.997**
T_2	1.031	-4.616**	-0.425	0.698	0.367**	0.374	2.947*	5.246**
T_3	-0.172	4.164**	0.450	1.375	0.546**	7.384**	0.306	0.751
L_{11} x T_1	2.297**	-1.648	0.105	-0.009	0.008	2.874	3.758**	2.607
T_2	-1.447*	-0.576	0.122	0.145	0.158	5.092**	-9.508**	-1.009
T_3	-1.050	2.224	-0.227	-0.135	-0.166	-7.965**	5.750**	-1.598
L_{12} x T_1	1.519*	-2.743*	0.027	0.513	-0.047	1.874	-1.342	2.345
T_2	-1.292	2.100	-0.092	-0.240	0.117	-2.385	3.292**	1.978
T_3	-5.228**	0.643	0.065	-0.273	-0.070	0.511	-1.950	-4.324**
L.S.D.SCA 5%	1.398	2.295	0.493	1.497	0.224	2.960	2.235	2.685
L.S.D.SCA 1%	1.848	3.533	0.652	1.978	0.296	3.912	2.955	3.549

* and ** indicate significant at P ≤ 0.01 and P ≤ 0.05, respectively.

Five , ten , four and seven crosses had significant positive specific combining ability effects for spike weight , number of kernels / spike , 1000 – kernel weight and grain yield per plant, respectively .It could be concluded that parental Gemmeiza 10 might be selected as parental materials for wheat breeding programmes since its consider a good combiner for number of spikes / plant , number of kernels / spike and consequently grain yield / plant .

The line number 1 had highest general combining ability effect for number of spikes / plant, spike weight and 1000 –grain weight. The results obtained herein concerning general and specific combining ability effects could indicated that excellent hybrids combinations were obtained from the three possible combinations between the parents of high and low general combining ability effects i.e. high x high, high x low and low x low.

It could be concluded that general combining ability effects were generally unrelated to the specific combining ability of their respective crosses.

Therefore , from these results it may be concluded that in selection of parents for use in hybrid combinations it would be more profitable to select first on the basis of their general combining ability abilities , and further selection might then be guided by evaluation the specific combining ability effects . This conclusion was previously drawn by Hendawy (1994) , Hewezi (1996) , Koumber (1997) , Hamada *et al* (2002) , koumber and EL-Beially (2005) and Moshref (2006) .

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تقدير القدرة على الائتلاف للمحصول ومكوناته في قمح الخبز باستخدام تحليل السلالة × الكشاف

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أجرى هذا البحث فى محطة البحوث الزراعية بالجميزة مركز البحوث الزراعية –مصر فى المواسم الزراعية ٢٠٠٥/٢٠٠٤ و ٢٠٠٦/٢٠٠٥ وذلك بهدف دراسة القدرة على الائتلاف للصفات التالية : تاريخ طرد السنابل – طول النبات – طول السنبلة – عدد السنابل للنبات – وزن السنبلة – وزن الألف حبة – عدد الحبوب فى السنبلة – ومحصول الحبوب للنبات . وقد استخدم فى هذه الدراسة اثني عشر سلالة تم تهجينها مع ثلاثة كشافات محلية هى جميزة ٧ – جيزة ١٦٨ – جميزة ١٠ وأنتجت ٣٦ هجينا . وكانت أهم النتائج المتحصل عليها كما يلي :-

- كانت قيم التباين الراجعة إلى كل من التراكيب الوراثية والأباء والهجن عالية المعنوية لكل الصفات تحت الدراسة .
- كانت قيم التباين الراجعة إلى كل من الآباء والآباء مع الهجن والسلالات والكشافات عالية المعنوية لكل الصفات تحت الدراسة .
- أظهرت النتائج أن الفعل الجيني المضيف كان الأكثر أهمية فى توارث معظم الصفات تحت الدراسة فيما عدا صفتي تاريخ الطرد وطول السنبلة .حيث كان الفعل الجيني غير المضيف هو المتحكم فى وراثة تلك الصفات .
- أظهرت النتائج أن السلالة رقم ١ والصنف جميزة ١٠ ذات قدرة تألف عالية للمحصول ومكوناته ويمكن الاستفادة منها بإدخالها فى برامج التربية كمواد وراثية .