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GENE ACTION FOR YIELD AND ITS COMPONENTS IN BREAD WHEAT (*Triticum aestivum*, L.)

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ABSTRACT

Gene action for yield and its contributing characters *i.e.*, number of tillers/plant, number of spikes/plant, number of grains/spike, 1000-grain weight and grain yield/plant for eight Egyptian bread wheat genotypes, were studied using 8 x 8 diallel crosses, excluding reciprocals. The studied genotypes were Sakha 92, Sakha 69, Sakha 8, Giza 160, Gemmiza 7, Gemmiza 3, Giza 163 and Giza 164, 8 parents and 28 F_1's were sown in randomize complete block design in 3 replicates. The obtained data were genetically and statistically analysed using Griffing (1956) Modle 1 and method 2 to estimate combining ability. Hayman (1954 a and b) and Jones (1956) were used to calculate genetic components.

Results indicated that mean squares of general and specific combining ability were significant for all studied characters. Sakha 92 and Sakha 69 cultivars were good general combiners for number of grains/spike and grain yield/plant. While, Gemmiza 3 and Gemmiza 7 cultivars as well as spikes/plant and 1000 grain weight were good general combiners for number of tillers/plant and number of spikes/plant. The two crosses Sakha 92 X Giza 160, Sakha 8 X Giza 160 and Gemmiza 3 X Gemmiza 7 could be considered promising crosses and obtain transgressive segregation. The mean squares for types of gene action obtained by Jones method (1956) indicated that additive genetic variance (a) was significant for all studied characters. The dominance genetic variance (b) was significant for all characters, except 1000-grain weight. By using second degree statistic (Hayman, 1954 a and b) results indicated that, the additive genetic variance was significant for number of tillers/plant, number of spikes/plant and 1000-grain weight. The dominance genetic variance H_1 was significant for all characters, except 1000-grain weight. Results indicated that, the dominance gene variance accounted for the most parts of the total variation for number of spikes/plant, number of grains/spike and grain yield/plant ratio of $(H_1/D)^{0.5}$ was more than one. Both positive and negative alleles $(H_2/4H_1)$ were unequally distributed among parent for all characters. Heritability in narrow sense was, 0.684 for number of tillers/plant, 0.077 for number of spikes/plant, 0.495 for number of grains/spike, 0.361 for 1000-grain weight and 0.421 for grain yield/plant. It could be concluded that Sakha 69 and Sakha 92 cultivars possessed more favorable gene for yield and its components.

INTRODUCTION

Improvement of yield and its components of wheat genotypes is the main goal of wheat breeders. The progress of any breeding program depends upon the available genetic information in the studied materials. The materials under investigation should be subjected to genetic analysis in order to find out the relative magnitude of various types of genetic variances.

The present investigation deals with the estimation of gene action and heritability for wheat. Genetic variance in wheat for yield and its components was studied by AL-Kaddoussi *et al.* (1994) ; Eissa *et al.* (1994) ; AL-Kaddoussi (1996) and Ageez and EL-Sherbeny (1998). Many investigators studied Diallel analysis in wheat for yield and its components and found that, the additive and dominance gene effects had the important role in the inheritance for these characters by Ali and Khan (1998) ; Yadav *et al.* (1998) ; Chowdhry *et al.* (1999) and Esmail (2002).

The present investigation was under taken to obtain information about gene action, combining ability and heritability for yield and its components of eight Egyptian bread wheat genotypes in half diallel, excluding reciprocals using Model 1 and method 1.

MATERIALS AND METHODS

Eight genetically diverse bread wheat genotypes given in Table 1 were crossed in half diallel to obtain 28 F_1`s. Parents (8) and $F_1$`s (28) were evaluated in 2001/2002 winter growing seasons, using diallel cross, excluding reciprocals. The eight parents their 28 F_1`s crosses were sown in 5^{th} November 2002 at Awlad Sakar district, Sharkia governorate in private farm and evaluated using a randomized complete block design with three replicates. Each plot consisted of 6 rows (2 rows for each parent and F_1). Rows length was 2 m, rows was 20 cm apart, plant spacing was 10 cm.

Recorded data:

Ten guarded and completive plants were randomly chosen for each of the parental genotypes and F_1`s to study number of tillers/plant, number of spikes/plant, number of grains/spike, 1000-grain weight (g) and grain yield/plant (g). The obtained data were subjected, firstly, to the usual analysis of variance (two way) according to Stell and Torrie (1980). General and specific combining ability variances were estimated using mode 1, method 2 of Griffing (1956). Assessment and quantifying the types of gene action were computed according to Hayman (1954 a and b), Jones (1956) and Mather and Jinks (1982). Recommended agricultural practices for wheat production were applied at the proper time.

Table 1: Pedigree of the studied parental genotypes.

Serial number	Genotypes	Pedigree	Origin
1	Sakha 92	Napo 63 / Inia 661 / Wern "5"	Egypt
2	Sakha 69	Inia / RL 4220 // 7C / Yr "5"	//
3	Sakha 8	Indus / Norteno "5"	//
4	Giza 160	Chenab 70 / Giza 155	//
5	Gemmeiza 7	CMH 74 A. 360 / SX // Seri 8213 / Agent	//
6	Gemmeiza 3	Bb / 7C * 2 // Y 50 E / Kal * 3 X Sakha 8 / 4 / PRV / WW 15 / 3 / Bj "5" // On * 3 / Bon	//
7	Giza 163	Vcm // C no 67 / 7C / 3 / Kal / Bb	//
8	Giza 164	Kvz / Buha "5" // Kal / Bb	//

RESULTS AND DISCUSSION

A: Analysis of variance:

Mean squares for combining ability (general and specific) [Table 2] indicated that general and specific combining ability variance were significant for all studied characters, suggesting the presence of additive and non-additive gene effects controlling these characters. The results of δ^2 GCA / δ^2 SCA indicated that there out of the studied characters were more than unity, giving evidence that these characters are controlled by additive gene action. These characters *i.e.*, number of grains/spike, 1000-grain weight and grain yield/plant could be improved through phenotypic selection, meanwhile, the other tow characters could be improved through hybrid breeding method . These results are in accordance with those obtained by Dasgupta and Mondal (1988) and Salama (2000).

Table 2: Mean squares of general (GCA) and specific combining ability (SCA) for yield and yield components in half diallel 8 X 8 in bread wheat.

S.O.V.	d.f	Number of tillers/ plant	Number of spikes/ plant	Number of grains/ spikes	1000-grain weight (g)	Grain yield/plant (g)
G.C.A.	7	1.763**	1.336**	131.14**	13.637**	27.672**
S.C.A.	28	2.183**	1.764**	66.78**	3.852**	20.58**
Error	70	0.328	0.254	8.597	1.622	4.553
δ^2G.C.A. /δ^2 S.C.A		0.807	0.757	1.963	3.540	7.344

B: General combining ability effects (G.C.A.)

Results of general combining ability effects which refer to additive and additive X additive gene action are shown in Table 3. Positive and significant G.C.A. effects was observed for Sakha 92 (number of grains/spike, 1000-grain weight and grain yield/plant) and Sakha 69 for number of grains/spike, number of spike/plant and grain yield/plant. These parents could be involved in breeding program to improve these characters. The obtained results were in harmony with those recorded by Dasgupta and Mondal (1988) ; AL-Kaddoussi (1996) and Salama (2000) for number of grains/spike and 1000-grain weight and Awaad (1996) and Salama (2000) for grain yield/plant. It could be concluded that Sakha 92 and Sakha 69 cultivars possessed more favorable gene for yield.

C: Specific combining ability effects (G.C.A.)

Results of specific combining ability effects are given in Table 4. The obtained results showed that the best cross combination was Sakha 8 X Giza 160, since it possessed the most positive and significant S.C.A. for number of tillers/plant and number of spikes/plant. Cross combination Gemmiza 7 X Gemmiza 3 possessed positive and significant S.C.A. for number of grains/spike, 1000-grain weight and grain yield/plant. Also, Sakha 92 X Giza

160 give positive and significant S.C.A. for number of tillers/plant, number of spikes/plant and 1000-grain weight. These results revealed that these crosses could be involved in breeding program to improve these characters. It could be noticed that 6 crosses combinations contained 2 positive and significant S.C.A. for various characters. Also, 10 crosses possessed positive and significant S.C.A. for single characters that differed cross tom cross.

D: Variance component:

Results of the analysis of variance by Jones (1956) are given in Table 5. The "a" item indicated significant additive gene effects was for all studied characters. While, the item "b" was significant for all characters, except 1000-grain weight. Similar results were reported by Awaad (2002) and Hamada (2003), where they found significant additive and dominance gene effects for yield and its components in wheat. The differences between F_1 and the average of parents (P) indicated heterotic effects (significant b_1 item) for all characters. Also, significant b_2 item for all characters, except 1000-grain weight indicated that, the dominance genes were not equally distributed and superior genotypes could be isolated . The b_3 which refer to specific combining ability (Griffing, 1956) indicated the presence of considerable heterotic effects specific to some crosses combinations for number of grains/spike.

Table 3: General combining ability (GCA) effects for yield and yield components in half diallel 8 X 8 in bread wheat.

Characters Parents	Number of tillers/plant	Number of spikes/plant	Number of grains/ spikes	1000-grain weight	Grain yield/plant
Sakha 92	- 0.580	- 0.324	5.552	0.900	2.115
X`	11.00	9.97	68.23	42.19	24.36
Sakha 69	0.300	0.299	4.140	- 0.184	2.408
X`	8.70	8.23	66.83	44.21	20.85
Sakha 8	- 0.551	- 0.462	1.135	0.713	- 0.447
X`	11.20	10.47	70.00	42.35	25.86
Giza 160	0.109	- 0.320	- 1.458	0.097	- 1.533
X`	10.47	9.97	79.23	41.69	27.32
Gemmiza 7	0.419	0.375	- 5.462	- 2.468	-2.546
X`	7.37	6.87	77.70	47.81	21.89
Gemmiza 3	0.460	0.428	- 3.091	- 0.707	- 0.319
X`	7.33	7.17	79.93	45.23	22.94
Giza 163	- 0.295	- 0.221	0.255	1.164	0.115
X`	10.17	9.43	74.23	40.91	24.81
Giza 164	0.136	0.223	- 1.076	0.485	0.172
X`	9.10	8.30	74.77	39.96	20.87
S. Egi	0.167	0.149	0.858	0.372	0.625

Table 4: Specific combining ability effects (SCA) for yield and yield components in half diallel 8 X 8 in bread wheat.

	Number of tillers/ plant	Number of spikes/ plant	Number of grains/ spikes	1000-grain weight	Grain yield/plant
Sakha 92 X Sakha 69	- 0.499	- 0.445	- 0.119	0.278	- 0.425
Sakha 92 X Sakha 8	2.263**	- 0.011	- 0.365	- 2.362*	- 3.670*
Sakha 92 X Giza 160	1.142**	1.052**	0.625	2.463*	- 1.866
Sakha 92 X Gemmiza 7	0.101	0.252	2.362	3.541**	- 0.409
Sakha 92 X Gemmiza 3	1.018**	- 0.354	- 0.321	1.062	- 0.332
Sakha 92 X Giza 163	0.532	- 0.218	3.651	- 0.324	3.302*
Sakha 92 X Giza 164	- 0.005	0.536	- 0.691	1.202	- 0.781
Sakha 69 X Sakha 8	- 0.682	- 0.202	2.754	0.326	- 1.030
Sakha 69 X Giza 160	1.531**	1.431**	1.352	0.014	1.047
Sakha 69 X Gemmiza 7	0.220	- 1.085**	6.823**	4.822**	1.734
Sakha 69 X Gemmiza 3	- 0.114	1.440**	2.652	2.361*	2.801
Sakha 69 X Giza 163	0.216	1.030**	- 1.652	- 0.952	0.985
Sakha 69 X Giza 164	1.031**	- 1.020**	- 0.068	- 0.013	- 3.678*
Sakha 8 X Giza 160	0.826*	0.651*	- 1.078	3.683**	5.812**
Sakha 8 X Gemmiza 7	0.152	0.663*	- 0.638	2.544*	2.189
Sakha 8 X Gemmiza 3	1.036*	- 0.322	- 0.751	- 0.621	0.796
Sakha 8 X Giza 163	0.022	- 0.431	- 0.252	0.328	- 2.670
Sakha 8 X Giza 164	- 0.011	- 0.028	- 0.342	0.202	1.407
Giza 160 X Gemmiza 7	- 0.123	- 0.032	5.448**	1.622	2.363
Giza 160 X Gemmiza 3	- 0.542	- 0.003	1.090	1.542	- 4.980**
Giza 160 X Giza 163	- 0.060	0.521	0.622	1.638	0.634
Giza 160 X Giza 164	0.810	0.361	0.381	1.893	1.001
Gemmiza 7 X Gemmiza 3	0.550	0.263	4.623*	3.933**	5.327**
Gemmiza 7 X Giza 163	0.202	- 0.408	0.297	2.204**	1.071
Gemmiza 7 X Giza 164	0.301	- 0.108	5.832**	0.141	7.158**
Gemmiza 3 X Giza 163	0.108	- 0.001	- 0.003	0.321	- 0.412
Gemmiza 3 X Giza 164	0.029	0.070	4.938*	0.202	5.155**
Giza 163 X Giza 164	- 0.545	0.352	1.997	- 0.451	- 0.321
S. Egi	0.451	0.397	2.312	1.004	1.682

Table 5: Mean squares of the half diallel analysis of variance for yield and yield components.

S.O.V.	d.f	Number of tillers/ plant	Number of spikes/ plant	Number of grains/ spikes	1000-grain weight (g)	Grain yield/plant (g)
a	7	1.763**	1.336**	131.14**	13.637**	27.672**
b	28	0.799*	0.634*	20.182*	2.280	14.207*
b_1	1	4.589**	4.392**	48.72**	9.076**	86.100**
b_2	7	1.220**	0.745**	22.24**	2.042	20.552**
B_3	20	0.462	0.467	18.034*	2.032	8.388
Error	70	0.328	0.254	8.597	1.622	4.553

The genetic components of variance (Table 6) showed significant additive gene effects (D) for number of tillers/plant, number of spikes/plant and 1000-grain weight. Whereas, the dominance H_1 was significant for all characters, except 1000-grain weight.

The "F" value was positive and significant for number of tillers and spikes/plant suggesting that increasing alleles were more frequent than decreasing ones in the parents.

The ratio $(H_1/D)^{0.5}$ was more than one for number of spikes/plant, number of grains/spike and grain yield/plant suggesting that, over dominance gene effects were the prevailed type in the genetics of these characters exhibited epistatic gene effects for these characters.

The ratio $[H_2/4H_1]$ were less than its maximum values 0.25 for all characters, indicating asymmetric distribution of both positive and negative alleles among parents. The proportion of dominant to recessive gene [KD/KR] was more than one for number of tillers and spikes/plant as well as grain yield/plant indicated the prevalence of dominant alleles in the genetics of these characters.

Narrow sense heritability was 0.684 for number of tillers/plant, 0.077 for number of spikes/plant, 0.495 for number of grains/spike, 0.361 for 1000-grain weight and 0.421 for grain yield/plant. Broad sense heritability values were high for all characters, except 1000-grain weight.

Table 6: Additive [D], dominance (H_1 and H_2) and environmental [E] genetic components together with drived parameters for yield and yield components in half diallel 8 X 8 in bread wheat.

	Number of tillers/ plant	Number of spikes/ plant	Number of grains/ spikes	1000-grain weight (g)	Grain yield/plant (g)
D	0.227 ±0.028	0.222 ± 0.023	0.0596± 0.079	0.378 ± 0.140	0.195 ± 0.636
H_1	0.138 ± 0.065	0.242 ± 0.053	4.688 ± 1.834	0.102 ± 0.340	6.307 ± 1.463
H_2	0.068 ± 0.056	0.170 ± 0.046	2.755 ± 1.595	0.068 ± 0.296	3.556 ± 1.272
F	0.253 ± 0.067	0.280 ± 0.054	-5.26 ± 1.825	- 0.240 ± 0.34	0.366 ± 1.503
h^2	2.627 ± 0.038	2.118 ± 0.039	0.225 ± 1.070	4.167 ± 0.198	41.534 ±0.853
E	0.110 ± 0.009	0.041 ± 0.007	3.024 ± 0.026	0.560 ± 0.049	0.608 ± 0.21
Drived parameters					
$(H_1 / D)^{0.5}$	0.779	1.044	8.869	0.519	5.689
$(H_2 / 4H)$	0.123	0.176	0.146	0.167	0.141
(KD/KR)	6.060	4.060	- 9.561	0.240	1.401
T_n	0.684	0.077	0.495	0.361	0.421
T_b	0.726	0.546	0.589	0.379	0.745

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الفعل الجينى للمحصول ومكوناته فى قمح الخبز

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أجريت هذه الدراسة خلال موسمى ٢٠٠١/٢٠٠٢ و٢٠٠٢/٢٠٠٣ بغرض دراسة النظام الوراثى وتجزئته إلى مكوناته المختلفة لصفات عدد الأشطاء للنبات ، عدد السنابل للنبات ، عدد حبوب السنبلة ، وزن الألف حبة ومحصول حبوب النبات لثمانية أصناف من قمح الخبز المصرى والجيل الأول الناتج عن هجن الدياليل مستبعداً الهجن العكسية وهذه الأصناف هى: سخا ٩٢ ، سخا ٦٩ ، سخا ٨ ، جيزة ١٦٠ ، جميزة ٧، جميزة ٣ ، جيزة ١٦٣ وجيزة ١٦٤. وتم تحليل البيانات إحصائياً ووراثياً بإستخدام ثلاث نماذج من تحليل الدياليل وهى جرفنج ١٩٥٦ وجونز ١٩٥٦ وهايمان ١٩٥٤ أ ، ب وتلخصت النتائج فى الآتى:

١- أوضحت النتائج أن التباين الراجع للقدرة العامة والخاصة على التآلف كان معنويا لجميع الصفات المدروسة.

٢- أظهرت النتائج أن الصنف سخا ٩٢ والصنف سخا ٦٩ كانا أفضل الأباء فى القدرة العامة على التآلف لصفتى عدد حبوب السنبلة ومحصول الحبوب للنبات بالإضافة إلى وزن الألف حبة وعدد السنابل للنبات. بينما كان الصنف جميزة ٧ والصنف جميزة ٣ أفضل الأباء فى القدرة العامة على التآلف لصفتى عدد الأشطاء والسنابل للنبات.

٣-أشارت النتائج أن الهجين سخا ٩٢ × جيزة ١٦٠ (عدد الأفرع للنبات ، عدد السنابل للنبات ، وزن الألف حبة ، ومحصول الجبوب للنبات) وسخا ٨ × جيزة ١٦٠ (عدد الحبوب للنبات ، وزن حبوب النبات ، ووزن الألف حبة) و جميزة ٧ × جميزة ٣ (عدد الأفرع للنبات ، عدد السنابل للنبات ، وزن الألف حبة) أفضل الهجن فى القدرة الخاصة على التآلف ويمكن الحصول منها على إنعزالات فائقة الحدود لتلك الصفات.

٤- أظهر تحليل التباين بإستخدام طريقة جونز (١٩٥٦) أن التباين الراجع للفعل الجينى المضيف "a" كان معنويا لجميع الصفات المدروسة بينما كان التباين الراجع للفعل السيادى "b" معنويا لجميع الصفات ما عدا وزن الألف حبة.

٥- أظهر التحليل بطريقة هايمان (١٩٥٤ أ وب) أن التباين المضيف كان معنويا لصفات عدد الأشطاء للنبات وعدد السنابل للنبات ووزن الألف حبة. بينما كان التباين الراجع للفعل السيادى للجين معنويا لجميع الصفات ما عدا وزن الألف حبة.

٦- أظهرت النتائج أن المكون السيادى هو المكون الأعظم لصفات عدد السانبل للنبات ، عدد حبوب السنبلة ومحصول الحبوب للنبات حيث كانت النسبة $(H_1/D)^{0.5}$ أكبر من الوحدة.

٧- توزعت كلا من الجينات الموجبة والسالبة توزيعا غير متماثلا بين الأباء لجميع الصفات حيث كانت النسبة $(H_2/4H_1)$ أقل من ٠,٢٥.

٨- كانت قيمة كفاءة التوريث بالمعنى الضيق ٠,٦٨٤ لصفة عدد السنابل للنبات ، ٠,٠٧٧ لصفة عدد السنابل للنبات ، ٠,٤٩٥ لصفة عدد حبوب السنبلة ، ٠,٣٦١ لصفة وزن الألف حبة و٠,٤٢١ لصفة محصول الحبوب للنبات.

٩- هذه الدراسة توضح أن أفضل الأصناف بالنسبة لزيادة كمية المحصول هما سخا ٦٩ وسخا ٩٢ ويمكن الحصول منهما على إنعزالات فائقة الحدود.