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GENE ACTION AND HERITABILITY OF DIALLEL CROSSES IN BREAD WHEAT *(Triticum aestivum* L.*)* UNDER VARIOUS NUMBER OF IRRIGATIONS

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ABSTRACT

The genetic system controlling yield and its contributing i.e., flag leaf area, days to heading, number of spikes/plant, number of grains/spike, 1000-grain weight and grain yield/plant for six local and bread wheat genotypes were studied, under three treatments of irrigations (1-six irrigates 2- four irrigates 3- two irrigates). The diallel cross among parental genotypes in all possible combinations, exculuding reciprocals was used. The studied genotypes were, Sakha 93, Giza 168, Sahel 1, Gemmeiza 7, Gemmeiza 9 and Sids 1. This investigation was carried out during 2005/2006 and 2006/2007 seasons at Tag El-Ezz Agricultural Research Station, Dakhlia Governorate. In the second season 2006/2007 the obtained F_1's together with the six parents were evaluated in randomized complete block design with three replicates for each treatment of irrigation. The obtained results showed that, mean squares for types of gene action according to Jones Method (1956), additive genetic variance (a) was significant for all characters under various irrigation treatments. Whereas, the dominance genetic components (b) was significant for all characters except, number of spikes/plant for first treatment of irrigation (I_1). By using second degree statistic (Hayman, 1954) results indicated that, the dominance genetic variance accounted for days to heading, number of spikes/plant (I_1, I_2 and I_3), number of grains/spike (I_1) and grain yield/plant (I_1 and I_2) resulting in $(H_1/D)^{0.5}$ which was more than unity. Both positive and negative alleles ($H_2/4H_1$) were not equally distributed among parents for all characters, except number of spikes/plant (I_1). Heritability in narrow sense was more than 50% for flag leaf area and days to heading (I_1, I_2 and I_3) as well as number of spikes/plant (I_3).

The mean squares of general and specific combining ability were significant for all characters. The wheat cultivars, Gemmeiza 7 and Gemmeiza 9 proved to be good general combiners. Wheat crosses; Sakha 93 X Gemmeiza 9, and Gemmeiza 7 X Sids 1 could be considered promising crosses and the best crosses combinations displayed for amount of heterotic effects for grain yield/plant.

INTRODUCTION

Bread wheat *(Triticum aestivum L.)* is considered the unique cereal crop in both Egyptian and world cultivation. The uniqueness of wheat crop arises from its multiple usage in human consumption. The exponential increase in Egyptian population in comparison with the limited cultivated area, enhances the responsibility of plant breeders to bridge this gap through improving and developing high yielding wheat genotypes as a quick and cheaper solution in present time. The diallel analysis provide detailed genetical information about specific genotypes before including in breeding programs. Many researches used diallel technique to obtain genetical information about yield and yield contributing characters in this respect, Mosaad *et al*., (1990), Alkaddoussi *et al*. (1994); Awaad (1996); Salama *et al* (2006), these researches studied gene action and genetic that controlled yield and yield contributing characters. The importance of dominance for flag leaf area, days to heading and grain yield/plant were studied by Shehab El-Din (1997); Ab-El-Aty (2002) and Esmail (2002). The importance of additive and dominance gene action for 1000-grain weight and number of grains/spike were detected by Salama (2000), and Salama *et al*., (2005). Many researchers used diallel cross techniques in wheat, i.e. Eissa *et al*. (1994); El-Hindi *et al*. (2005) and Sultan *et al* (2005).

The present investigation was undertaken to obtain genetic information involving gene action of genetic system, and heritability for yield and yield contributing characters in half diallel to 6 x 6 local wheat genotypes.

MATERIALS AND METHODS

1- Experimental layout and the studied materials:

Six genetically diverse wheat genotypes of local origin were crossed in half diallel, excluding reciprocals, in 1st season; 2005/2006 to obtained 15 F_1's. The pedigree and origin of the studied parents are presented in Table (1).

Table (1). Pedigree and origin of the studied bread wheat genotypes.

Serial number	Genotypes	Pedigree	Origin
1	Sakha 93	Sakha 92 / TR 810328-5887/15-25-15-05	Egypt
2	Giza 168	MRL / BUC// Seri CM 93046-8M-04-OM-2Y-OB-062	Egypt
3	Sahel 1	N.S. 732 / PIM // Veery "S"	Egypt
4	Gemmeiza 7	CM74A. 630 / Sx // Seri 82/ 3/ Agent	Egypt
5	Gemmeiza 9	ALD "S" Huac "S" // CMH 74A/6301	Egypt
6	Sids 1	HD2171/Pavon "S"//1158. 57/rlaya	Egypt

Three field experiments were conducted at Tag El-Ezz Agricultural Reaserch Station, Dakahlia governorate, Agriculture Research Center (ARC) and evaluated in three experiments for 2006/2007 grown season.

The first experiment received 6 irrigations (I_1). The 2nd experiment received 4 irrigations. Meanwhile, the 3rd experiment received 2 irrigations (I_3) with sowing irrigation various irrigations treatments were applied under 15 F_1's and 6 parents in randomized caplete block design with three replicates. The plot of all experiments consisted of 6 rows (2 rows to for each parent and F_1's). Row length was 2m, row to row spacing was 20 cm, plant to plant spacing was 10 cm. All agricultural recommended practices for wheat production at the area of study, except irrigation, were applied at the proper time.

The aims of this study to obtained genetic inforation under wheat various irrigations, including gene action and heritability.

2- Collected data:

The following characters were meagured at the proper time for parents and F_1's using sample of 10 gaurded and competitive plants for F_1's and each parents:

Flag leaf area (cm^2), days to heading (day), number of spikes/plant, number grains/spikes (average mean of 10 main spike). Thousand grain weight (g.), and Grain yield / plant (g.)

3- Statistical analysis:

The obtained data were subjected, firsty to convential two way analysis of variance according to Steal and Torrie (1980).

Assessment and quantifying types of gene action were computed according to Hayman (1954), Jones (1956), and Mother and Jinks (1982).

General (GCA) and specific (SCA) combining ability variances and effects were estimated using modell I and methods 2 (Griffine, 1956). Rank correlation (rs) between mean performance and GCA effects were computed.

RESULTS AND DISCUSSION

Mean squares of half diallel analysis of variance for studied characters (Table 2) indicated significant mean squares of additive "a" for all studied characters in three treatments (I_1,I_2 and I_3) of irrigations, indicating the importance of additive gene action in controlling these characters. The important of dominance gene effects "b" in the inheritance of studied characters were shown for all studied characters, except number of spikes/plant (I_1). The obtained results were in harmony with those obtained by Alkaddoussi *et al*. (1994); Salama *et al* (2005) and Salama and Manal Salem (2006).

When the dominance component "b" was partitioned to b_1, b_2 and b_3 components, results of b_1 indicated that dominance was unidirectional for all characters, except number of spikes/plant for I_1, expressing ambidirectional. The significance of b_2 component for all studied characters, indicating that dominant genes were not equally distributed among parental genotypes. The specific combining ability as indicated by b_3 were highly significant for all studied characters except, number of spikes/plant for I_1 and I_3 and grain yield / plant for I_1 and I_2 significant b_3, suggesting superiority of some specific combinations which many display a high potential of genetic variability, expected to produce high yielding wheat genotypes. Significant b_1, b_2 and b_3 were detected for 1000-grain weight and grain yield/plant in bread wheat (Alkaddoussi *et al.,* 1994 and Salama 2000).

Using second degree statistics Hayman (1954), various genetic parameters were computed (Tables 3 and 4) and indicated that both additive (D) and dominance (H_1 and H_2) effects were significant for all the studied characters, indicating the importance of additive and dominance gene effects for controlling these characters. The dominance genetic variance was higher of magnitude as compared to additive variance resulting in $(H_1/D)^{0.5}$ exceeding more than unity for days to heading and, number of spikes/plant

2+3

for all treatments of irrigations, number of grains /spike (I_1) and grain yield/plant (I_1 and I_2), thus hybrid breeding method would be an effective method for improving these characters. In this respect over dominance gene effects was reported for number of spikes/plant (Dasgupta and Mondal 1988), as well as number of grains/spike, 1000 grain weight and grain yield/plant [Eissa 1989; Al-Kaddoussi *et al*. 1994, Al-Kaddoussi 1996 and Awaad 1996)]. On the other hand, the remaining characters, the additive genetic variance was more than the dominance one. $(H_1/D)^{0.5}$ was less than unity indicating the importance of additive gene effects in controlling these characters.

The covariance of additive and dominance gene effect in the parents revealed significant and positive "F" values for days to heading, number of grains/spike; 1000-grain weight and grain yield / plant for all treatments of irrigation, indicating that the dominant alleles were more frequent than the recessive ones in the parent for these characters, while negative "F" value for remaining characters indicated excess of recessive alleles among parents. The overall dominance effects of heterozygous loci (h^2) indicated directional dominance for flag leaf area, number of spikes/plant and number of grains/spike for all treatments; days to heading for I_1 and I_2, 1000- grain weight and grain yield / plant for I_1. The proportion of genes with positive and negative effects in the parent (H_2 / $4H_1$) were approximately equal to 0.25 for number of spikes / plant for I_1 and I_2 indicating equally distribution of positive and negative genes in the parental genotypes for this character. But, for the remaining characters (H_2 / $4H_1$) deviated from its maximum value (0.25). Thus, genes controlling these characters were not equally distributed among parents.

The ratio of dominance to recessive alleles (KD/KR) in the parents indicated the preponderance of dominance alleles which was >1 for all characters, except flag leaf area showed an excess of decreasing alleles among parental genotypes. Narrow sense heritability (T_n) was more than 50% for flag leaf area, days to heading in all treatments and number of spikes/plant for I_3. Heritability in broad sense ranged from 0.569-0.973 for all the studied characters under various irrigation treatments.

Mean squares for combining ability (Table 5) indicated that general (gca) and specific (sca)combining ability variances were significant for all characters, suggesting presence of additive and dominance gene effects in the inheritance of these characters. These results are in accordance with those obtained by (Eissa 1993, and Salama and Manal Salem 2006). The sca exceeded gca for number of spikes / plant and grain yield / plant (all treatments of irrigations), suggesting that non-additive gene effects accounted for the great part of the total variation for these characters. Thus, selection for these characters should be practised in to later generations.

The results in Table (6) indicated that general combining ability (gca) effects which refer to additive and additive x additive gene effects was positive and significant for flag leaf area for I_2 and I_3 (Gemmeiza 9), days to heading I_1, I_2 and I_3 (Sahel 1) and I_3 (Gemmeiza 7); number of spikes/plant I_1 (Gemmeiza 7), I_2 (Gemmeiza 9 and Sids 1) and I_3 (Giza 168 and Gemmeiza 9), number of grains/spike I_1 (Sakha 93) and I_3 (Sids 1), 1000-grain weight I_1 (Gemmeiza 7) and Gemmeiza 9) and I_2 with I_3 for Gemmeiza 9 and grain

4+5

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yield/plant for I_1, I_2 with I_2 (Gemmeiza 7 and Gemmeiza 9). It could be concluded that Gemmeiza 7 and Gemmeiza 9 possessed more favorable genes for yield and its components in bread wheat. The obtained result were in harmony, with those detected by (Dasgupta and Mondel, 1988, Al-Kaddoussi, 1996 and Salama and Manal Salem, 2006).

The results of rank correlation between gca effects and performance revealed positive and significant value for number of grains/spike and 1000 -grain weight for three treatments of irrigations, indicating that parents could be judge through mean performance of these characters. Thus, when the characters is unidirectionally controlled by additive gene action, the breeder could isolate good general combiners as early as possible using mean value as quick and reliable estimate. Similar results was reported by Eissa (1993), Awaad (1996) and Hassan (1998).

As seen in Table (7) specific combining ability effects (sca) indicated that the best crosses displayed positive and significant sca effects for flag leaf area I_2 and I_3 (Sakha 93 x Sahel 1; I_1 (Sakha 93 x Sids 1), I_2 and I_3 (Giza 168 x Gemmeiza 9); days to heading for I_1 and I_2 (Sakha 93 x Giza 168); I_2 (Sahel 1 x Gemmiza 7), I_3 Sakha 93 x Gemmeiza 7, Giza 168 x Sids 1, Sahel 1 x Gemmeiza 9, and Gemmeiza 7 x Gemmeiza 9); number of spikes/plant for I_1, I_2 and I_3 (Sakha 93 x Sids a and Gemmeiza 7 x Sids 1); number of grains / spike for I_1, I_2 and I_3 (Sakha 93 x Sids 1, Giza 168 x Gemmeiza 9; and Gemmeiza 7 x Gemmeiza 9); 1000-grain weight for I_2, I_2 and I_3 (Giza 168 x Sahel 1) and Sahel 1 x Sids 1) and grain yield / plant for I_1, I_2 and I_3 (Sakha 93 x Gemmeiza 9 and Gemmeiza 7 x Sids 1). It could be concluded that the cross combinations; (Sakha 93 x Gemmiza 9 and Gemmeiza 7 X Sids 1) displayed sca effects for, yield and its contributing characters, suggesting their importance in wheat breeding programs. It could be seen that less environmental influence (Stable crosses) enhancing its valuable as promising one for improving grain yield in bread wheat under various irrigations treatments.

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الفعل الجينى وكفاءة التوريث لهجن الدياليل فى قمح الخبز تحت عدد مختلف من الريات

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أجريت هذه الدراسة فى الموسم الشتوى لأعوام ٢٠٠٥/٢٠٠٦ و ٢٠٠٦ / ٢٠٠٧ وذلك بغرض دراسة تأثير ثلاثة معاملات من الرى وهى ٦ ريات، ٤ ريات، وريتين على الفعل الجينى وكفاءة التوريث لستة أصناف من قمح الخبز المصرى وهى: سخا ٩٣، جيزة ١٦٨، ساحل ١، جميزة ٧، جميزة ٩، سدس ١.

وتم دراسة الصفات التالية مساحة ورقة العلم، عدد الأيام حتى طرد السنابل، وعدد السنابل للنبات وعدد حبوب السنبلة ووزن الألف حبة، ومحصول الحبوب للنبات. وذلك بتهجين الستة أصناف بطريقة الدياليل مستبعداً الهجن العكسية وتم تقييم الجيل الأول والآباء بزراعتها بمحطة البحوث الزراعية بتاج العز دقهلية فى ثلاث معاملات من الرى كل على حدة فى تجربة منفصلة (ثلاث تجارب) فى ١٠ نوفمبر ٢٠٠٦ بإستخدام تصميم القطاعات العشوائية الكاملة فى ثلاث مكررات وتم تحليل البيانات إحصائياً ووراثياً بإستخدام نماذج الدياليل جونز ١٩٥٦ وهايمان ١٩٥٤ وجرفنج ١٩٥٦، وقد أوضحت النتائج الآتى:

١-أظهر تحليل التباين بطريقة جونز ١٩٥٦ أن التباين الراجع للفعل الجينى المضيف كان معنوياً لجميع الصفات بينما كان التباين الراجع للفعل السيادى (b) معنوياً لجميع الصفات ماعدا عدد السنابل للنبات معاملة الرى الأولى (٦ ريات).

٢-أظهر التحليل بطريقة هايمان ١٩٥٤ أن المكون السيادى هو المكون الأعظم فى وراثة عدد الأيام حتى طرد السنابل وعدد السنابل/نبات للثلاث معاملات من الرى وعدد حبوب السنبلة فى معاملة الرى الأولى (٦ ريات) ومحصول الحبوب للنبات فى معاملتى الرى الأولى والثانية (٦ ريات و ٤ ريات) وكانت قيم متوسط درجة السيادة أعلى من الوحدة لهذه الصفات.

٣-توزعت كل من الجينات الموجبة والسالبة توزيعاً غير متماثل بين الآباء لجميع الصفات ما عدا صفة عدد السنابل للنبات فى معاملة الرى الأولى (٦ ريات).

٤-كانت كفاءة التوريث بالمعنى المحدود أكبر من ٥٠% لمساحة ورقة العلم وعدد الأيام حتى طرد السنابل للثلاث معاملات من الرى وعدد السنابل للمعاملة الثالثة. بينما كانت أقل من ٥٠% لباقى الصفات.

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

٦-أظهرت النتائج أن الصنفين جميزة ٧ وجميزة ٩ كانت أفضل الآباء للقدرة العامة على التآلف لصفة محصول الحبوب ومعظم الصفات المرتبطة وأظهرت الهجن سخا ٩٣ × جميزة ٩ وجميزة ٧ × سدس ١ قدرة خاصة مرغوبة وعالية المعنوية ويمكن إستخدام هذه الهجن لزيادة محصول الحبوب للنبات (تحت ظروف الريات). وتؤكد النتائج أهمية إستخدام هذه الأصناف فى إنتاج وعزل تراكيب وراثية متفوقة فى المحصول ومكوناتة تحت ظروف الريات المختلفة.

Table (2): Mean squares of half diallel analysis of variance for studied characters under three treatments of irrigations in bread wheat Jones 1956.

Characters		Flag leaf area $(Cm)^2$			Days to heading (day)			Number of spikes/plant			Number of grains/spike			1000-grain weight (gm)			Grain yield /plant (gm)		
S.O.V.	D.F	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
a	5	68.916**	71.362**	53.27**	92.532**	111.291**	107.32**	0.823**	0.714**	0.652*	13.910**	14.622**	11.880**	16.522**	13.401**	15.834**	2.932*	1.106*	2.470**
b	15	51.326**	42.381**	36.281**	19.88**	20.232**	22.471**	0.521	0.823**	0.621*	19.141**	16.522**	17.362**	14.831**	12.693**	110.852**	1.902*	1.821**	1.793**
b_1	1	50.312**	32.163**	29.852**	16.481**	15.94**	17.503**	0.636	0.922**	0.722*	18.411**	17.932**	16.523**	20.414**	28.513**	26.142**	3.173**	3.252**	1.873**
b_2	5	21.522**	23.689**	27.112**	19.351**	18.420**	19.934**	0.962*	0.848**	0.751*	19.260**	19.253**	20.622**	21.413**	24.892	14.858**	4.169**	3.810**	2.461**
b_3	9	67.99**	53.900**	42.090**	20.55**	21.715**	24.432**	0.263	0.798**	0.520	19.156**	14.848**	15.644**	10.500**	4.602**	5.261*	0.506	0.557	1.413*
Error	40	2.611	3.292	3.848	5.170	0.362	6.473	0.403	0.259	0.310	4.823	3.031	4.312	3.94	2.33	2.82	0.907	0.423	0.692

I_1, I_2, and I_3 refers to 2, 4 and 6 irrigations.

Table (3): Additive (D), dominance (H) and environmental (E) genetic components together with derived parameters for flag area, days to heading and number of spikes/plant under three treatments of irrigation (I) of half 6 x 6 diallel cross in bread wheat.

Characters	Flag leaf area $(Cm)^2$			Days to heading (day)			Number of spikes/plant		
Parameters	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
D	10.300**±0.716	12.210**±0.652	11.74**±0.842	8.09**±0.978	9.362**±1.031	11.157**±1.079	0.819**±0.305	0.710**±0.285	0.780**±0.264
H_1	6.431**±1.818	7.090**±2.052	7.21**±2.141	22.176**±2.482	25.868**±2.619	28.202**±2.741	2.266**±0.775	1.420**±0.725	2.439**±0.671
H_2	5.662**±1.625	6.56**±1.833	6.94±1.913	6.122±2.218	7.604**±2.341	10.332**±2.449	2.253**±0.692	1.860**±0.648	1.298*±0.600
F	-3.300±1.731	-1.127±1.954	-3.51±2.038	15.721**±2.363	18.321**±2.494	21.808**±2.610	0.049±0.738	0.253±0.690	0.170±0.639
h^2	3.652**±1.093	4.272**±1.233	5.62**±1.287	6.960±1.492	0.419±0.955	31.571^{**+}1.648	19.06**±0.466	16.901**±0.436	10.614**±0.403
E	3.390**±0.270	3.681**±0.305	2.41**±0.318	0.179±0.368	0.178±0.389	0.174±0.407	0.153±0.115	0.095±0.107	0.081±0.100
Derived parameters									
$(H_1/D)^{0.5}$	0.790	0.762	0.591	1.655	1.662	1.589	1.659	1.644	3.126
$H_2/4H_1$	0.220	0.231	0.241	0.069	0.073	0.091	0.249	0.242	0.133
KD/KR	0.663	0.886	0.679	2.421	6.00	4.192	1.018	1.243	1.131
T(n)	0.599	0.566	0.651	0.711	0.691	0.567	0.350	0.315	0.683
T(b)	0.717	0.700	0.797	0.969	0.973	0.972	0.861	0.884	0.936

Table (4): Additive (D), dominance (H) and environmental (E) genetic components together with derived parameters for number of grains/spike, 1000, grain weight and grain yield/plant under three treatments of irrigation (I) of half 6 x 6 diallel cross in bread wheat.

Characters	Number of grains/spike			1000-grain weight (gm)			Grain yield/plant (gm.)		
Parameters	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
D	5.589*** ±0.916	11.649** ±3.141	10.999** ±1.085	17.009** ±1.063	13.11** ±1.103	10.70** ±0.978	8.32** ±0.709	8.940** ±0.74	10.28** ±0.763
H_1	17.674** ±2.325	7.535 ±2.703	10.489** ±2.755	15.138** ±2.70	11.38** ±2.615	7.700** ±2.482	10.05** ±1.802	9.69** ±1.921	9.100** ±1.94
H_2	11.136** ±2.013	5.568** ±2.415	5.396* ±2.460	10.418** ±2.412	9.616** ±2.337	6.08** ±2.218	6.98** ±1.616	6.50** ±1.716	8.48** ±1.732
F	6.874** ±2.215`	8.326** ±2.573	14.280** ±2.623	19.838** ±2.571	12.077** ±2.490	7.586** ±2.363	9.78** ±1.716	8.94** ±0.757	10.05** ±1.840
h^2	29.32** ±1.399	10.24** ±1.625	4.00* ±1.656	2.161 ±1.623	3.162 ±1.572	3.614** ±1.492	1.63 ±1.083	2.232 ±1.155	4.322** ±1.165
E	1.231** ±0.346	1.314** ±0.401	1.702** ±0.409	2.311** ±0.401	1.62** ±0.388	1.240** ±0.368	0.990** ±0.268	1.05** ±0.285	1.340** ±0.288
Derived param.									
$(H_1/D)^{0.5}$	1.778	0.804	0.976	0.943	0.931	0.848	1.099	1.041	0.941
$H_2/4H_1$	0.161	0.184	0.128	0.172	0.211	0.214	0.173	0.168	0.233
KD/KR	2.057	2.599	4.925	4.217	2.955	2.435	3.302	3.729	3.162
T(n)	0.395	0.402	0.227	0.161	0.259	0.383	0.227	0.206	0.109
T(b)	0.814	0.754	0.569	0.605	0.701	0.758	0.720	0.688	0.653

Table (5): Mean squares of general (gca) and specific combining ability (sca) for studied character under three treatment of irrigation (I) of half 6x6 diallel cross in bread wheat.

Characters		Flag leaf area $(Cm)^2$			Days to heading (day)			Number of spikes/plant			Number of grains/spike			1000-grain weight (gm)			Grain yield /plant (gm)		
S.O.V.	D.F	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
g.c.a	5	68.916**	71.362**	53.07**	92.532**	111.291**	107.32**	0.823**	0.714**	0.652*	13.910**	14.622**	11.880**	16.522**	13.401**	15.834**	2.932*	1.106*	2.470**
S.c.a	15	54.231**	44.262**	42.513**	91.143**	82.367**	58.40**	1.529**	1.913**	1.422**	13.183**	12.622**	11.198**	13.940**	6.879**	9.262**	3.315**	2.987**	3.038**
Error	40	2.611	3.292	3.848	5.170	6.362	6.473	0.403	0.259	0.310	4.823	3.031	4.312	3.94	2.33	2.82	0.907	0.423	0.692
$^2\delta gca/^2\delta sca$		1.270	1.612	1.248	1.015	1.221	1.837	0.538	0.373	0.458	1.055	1.158	1.061	1.185	1.948	1.709	0.884	0.370	0.813

Table (6): Mean performance, general combining ability effects and rank correlation for studied characters under three treatments of irrigation of half 6 x 6 diallel cross in bread wheat.

	Charac.	Flag leaf area (cm)^2			Days to heading (day)			Number of spikes/plant			Number of grains/spike			1000-grain weight (gm)			Grain yield/plant (gm)		
Parents		I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Sakha 93	GCA	0.646	0.261	0.710	1.263	-0.851	0.829	-0.260	-0.283	-0.534**	2.123**	-0.340	0.567	-0.241	-1.503*	-1.269*	-1.793**	-0.839**	-0.513
	X	38.61	36.25	30.22	93.15	90.00	87.33	11.23	9.72	7.16	65.60	49.71	45.16	52.97	48.66	40.83	13.69	11.82	9.87
Giza 168	GCA	1.031	0.924	0.011	0.071	0.614	0.630	-0.514**	-0.930**	0.721**	-3.152**	-0.341	-2.821**	-0.262	-0.265	-0.707	-0.071	-0.837**	0.001
	X	36.66	34.18	33.20	99.62	95.66	92.15	12.29	9.87	6.63	52.66	45,88	44.16	52.36	43.21	40.16	12.58	11.01	9.63
Sahel 1	GCA	-0.373	-2.202**	-1.948**	2.531**	1.940*	2.824**	-0.232	0. 025	-0.172	-0.070	-0.526	-2.142**	-3.610**	-0.259	-0.524	0.267	0.253	-0.282
	X	37.58	35.14	32.99	100.15	97.66	96.33	13.17	11.80	9.62	53.88	47.77	46.19	48.82	46.34	41.91	11.13	9.92	8.56
Gemmeiza 7	GCA	-1.242*	-0.312	-0.613	-2.21**	0.003	2.176**	0.674**	0.243	-0.614**	-0.282	0.894	0.941	2.147**	0.914	0.369	0.482*	0.491*	0.653*
	X	42.43	41.15	39.90	99.47	95.33	92.66	9.52	7.85	6.36	51.30	50.37	49.90	58.29	52.32	47.77	14.63	12.33	10.74
Gemmeiza 9	GCA	0.661	1.562**	1.503**	0.372*	-0.829	-1.797**	0.011	0.523**	0.542**	1.236	0.180	0.001	1.892**	1.858**	1.742**	0.810**	0.753**	0.652*
	X	43.28	40.72	37.91	103.33	101.33	98.15	8.95	7.62	5.38	64.30	60.16	47.22	59.11	52.39	49.76	13.85	12.07	10.82
Sids 1	GCA	-0.669	-0.233	0.337	-2.027**	-0.877	-4.662**	0.321	0.422**	-0.299	0.145	0.133	3.454**	0.074	-0.745	0.389	0.305	0.179	-0.511
	X	44.32	42.78	41.17	98.15	96.00	94.00	11.24	9.08	6.13	61.11	49.81	51.00	53.84	44.60	42.99	14.83	12.92	10.77
S.E (gi)		0.521	0.585	0.632	0.733	0.813	0.600	0.204	0.164	0.179	0.708	0.561	0.669	0.640	0.492	0.541	0.229	0.210	0.268
Rank corr.		-0.486	-0.142	0.029	0.029	0.200	-0.142	-0.486	-0.771	-0.086	0.943**	0.885*	0.857*	0.943**	0.828*	0.885*	0.543	0.257	0.543

Table (7): Specific combining ability (sca) for studied character under three treatments of irrigations in half 6 x 6 diallel crosses of bread wheat.

Characters	Flag leaf area (cm^2)			Days to heading (day)			Number of spikes/plant			Number of grains / spike			1000-grain weight (gm)			Grain yield / plant (gm)		
Crosses	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Sakha93 x Giza168	0.261	0.111	1.263	4.161**	5.310**	3.141	0.261	0.016	0.542	0.672	0.822	0.175	0.426	-0.534	0.172	0.111	0.362	0.157
Sakha 93 x Sahel 1	0.072	3236**	3.251**	0.023	-0.101	-0.252	-0.022	0.104	0.152	-0.693	-1.812	0.410	0.184	0.170	0.293	0.623	-0.510	0.232
Sakha93 x Gemmiza 7	-0.581	0.142	-0.651	1.111	2.322	4.621**	-0.132	-0.253	0.162	0.536	0.811	-0.936	0.460	0.508	0.272	-0.242	-0.163	-0.511
Sakha 93 x Gemmiza 9	0.718	-0.160	-0.651	-0.562	-0.211	-3.622	0.429	0.151	0.201	4.262**	5.36**	5.292**	-4.616**	-5.152**	-6.143**	1.678**	1.325**	1.724**
Sakha 93 x Sids 1	4.264**	2.152	1.122	-0.361	-0.822	0.811	1.413**	1.042**	1.262**	0.143	5.361	-6.264**	0.151	0.182	0.173	0.622	0.143	0.122
Giza168 x Sahel 1	0.102	0.682	2.829	0.032	0.013	0.024	0.581	-0.322	-0.178	0.541	0.006	0.178	5.81**	5.362**	7.263**	0.726	0.801	0.653
Giza168 x Gemmiza 7	-2.141	-0.142	-1.781	0.012	0.966	2.173	0.142	0.116	0.153	0.892	0.761	0.111	1.829	1.101	2.001	-0.013	-0.174	0.152
Giza168 x Gemmiza 9	-1.563	1.240	3.412**	0.172	-0.123	0.152	0.556	0.531	0.111	3.948**	4.751**	6.293**	0.152	0.143	-0.111	0.840	0.925	1.013
Giza 168 x Sids 1	-0.921	-0.523	-2.152	2.652	-1.826	-4.736**	-0.622	-0.132	0.107	-5.322**	-5.461**	-0.652	0.891	0.793	1.288	-0.814	-0.652	-0.163
Sahel 1 x Gemmiza 7	-0.822	0.222	-0.828	2.763	3.916	2.363	-1.612**	-1.480**	-1.222**	0.613	0.142	0.136	-1.793	1.429	1.653	-1.610**	-1.442**	-1.253**
Sahel 1 x Gemmiza 9	0.173	-0.006	0.712	2.93	0.781	4.610**	0.050	0.104	-0.006	0.858	0.006	0.963	-1.262	-1.422	0.819	-0.180	-0.114	0.126
Sahel 1 x Sids 1	-5.022**	-0.053	0.146	-2.654	1.282	0.101	-0.053	0.156	0.174	0.943	0.988	1.293	6.140**	4.812**	3.880**	0.593	0.114	0.801
Gemmiza 7 x Gemmiza 9	0.033	0.442	2.361	2.531	0.882	4.671**	0.236	0.482	-0.713	1.144	1.826	1.263	0.510	0.824	0.761	-0.101	-0.142	-0.123
Gemmiza 7 x Sids 1	0.042	-3.122**	-0.802	0.513	-0.142	0.072	1.411**	0.998**	0.923**	9.176**	8.411**	7.652**	-0.531	-0.172	0.822	1.931**	1.409**	1.873**
Gemmiza 9 x Sids 1	0.516	0.143	-0.011	-0.910	0.821	0.154	-0.154	-0.021	0.142	-5.361**	-4.252**	-5.130**	-0.717	0.163	0.183	-0.070	-0.182	-0.173
S.E sgi	1.183	1.328	1.436	1.436	1.664	1.847	0.464	0.378	0.367	1.456	1.274	1.520	1.453	1.117	1.229	0.521	0.476	0.609

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