Analysis of Yield and Its Components in Diallel Crosses of Bread Wheat

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ABSTRACT: A half diallel cross among seven parents of wheat (*Triticum aestivum*, L) was carried out at Etay El-Baroud Agricultural Research Station in El-Behira governorate during the three successive seasons 2012/13, 2013/14 and 2014/15 growing seasons in randomized complete block design (RCBD) with three replications. Data were recorded for F1 and F2 generations for grain yield /plant (g), number of spikes /plant, number of grains/spike, 1000-grain weight (g), straw yield /plant (g), biological yield /plant (g) and harvest index (%). Mean squares for genotypes, parents, crosses and parent vs. crosses were significant for all the studied traits for F1 and F2 generations. General combining ability (GCA) and specific combining ability (SCA) mean squares were significant for all the studied traits in both generations. GCA/SCA ratios were largely exceeded the unity for all the studied traits in both generations. Wheat cultivar Sids 12 (P1) showed the maximum desirable GCA values for number of grains / spike and 1000-grain weight (g) in both generations. The parent line 1 (P6) followed by Sham 6 (P5) proved to be good combiners for grain yield /plant, straw yield /plant and biological yield /plant. The parent Line 2 (P7) proved to be the best combiner for number of spikes /plant and harvest index. (Sahel 1 x Line 2) cross showed the maximum desirable SCA values for straw yield /plant and harvest index in F1 generation. As well as, for biological yield /plant in both F1 and F2 generations. (Gemmeiza 11 x Line 2) cross showed the best SCA for grain yield /plant and harvest index in F2 generation. (Gemmeiza 11 x Sham 6) cross gave the maximum SCA for number of spikes /plant and straw yield /plant in F2 generation. (Sids 12 x line 1) cross expressed the highest SCA for grain yield/plant and number of spikes /plant in F1 generation. (Sids 12 x Sahel 1) cross showed the maximum number of spikes /plant in F1 generation. For 1000-grain weight, (Sham 6 x line 1) and (Gemmeiza 11 x line 1) crosses gave the highest SCA in F1 and F2 generations, respectively.

Keywords: Bread wheat, Diallel analysis, General combining ability, Specific combining ability.

INTRODUCTION

Wheat (*Triticum aestivum*, L) is considering as one of the most important grain crops in the world, also it has been considered the first strategic food crop for more than 7000 years ago in Egypt. Wheat production in Egypt had been increased from 2.06 million tons in 1983 to 8.1 million tons in 2015 (Global Agric. Information Network (2016), FAO Statistical yearbooks – World Food and Agriculture). Increasing wheat production vertically or horizontally become the main goal to meet the increasing domestic demands and decreasing the gap between production and consumption in Egypt. Wheat breeders are concentrating to improve the grain yield potential of wheat by developing new cultivars with desirable genetic makeup in order to overcome the consumption pressure of increasing population (Memon *et al.*,2005). High grain yield has been the main objective in wheat breeding programs, hence, it has been the subject of intensive studies (Sharma *et al.*,2002).

The present study was planned to study the mean performance of parental wheat cultivars, F1'S and F2'S crosses for yield and its components and to estimation the general and specific combining abilities.

MATERIALS AND METHODS

This experiment was carried out at Etay El-Baroud Agricultural Research Station in El-Behira governorate during the three successive seasons 2012/13, 2013/14 and 2014/15 growing seasons. Seven wheat varieties,(*Triticum aestivum* L.), representing wide divergent origins were chosen for this study.The names, pedigree, origin and code number of these wheat genotypes are presented in Table (1)

Table (1).The code number, names pedigree and origin of the parental genotypes of the study.

No.	Variety	Pedigree	Origin
P1	Sids12	BUC//7C/ALD/5MAYA74/0N//1160/47/BB/GLL/4/CHAT"S"/6M AYA/VUL//CMH74A.63014*SX.SD7096-4SD-1SD-1SD-0SD.	Egypt
P2	Gemmeiza11	BOW"S"/ KVS"S"// 7C/ SERI 82/3/ GIZA 168/ SAKHA 61 GM-7892-2GM-1GM 2GM - 1GM -0GM	Egypt
P3	Giza168	MRL/BUC//SERI.CM93046-8M-0Y-0M-2Y-0B-0GZ.	Egypt
P4	Sahel1	N.S.732/PIMA//VEE"S"CR735-4SD-ISsD-ISD-0SD.	Egypt
P5	Sham 6	W-3918-A/JUPATECO-73.CM-39992-8M-7Y-0M-0AP-0SYR	Syria
P6	Line1	NINGMA150	Egypt
P7	Line2	MILAN/S87230//BABAX	Mexico

In 2012/13 season, grains from genotype were sown at various dates in order to overcome the differences in time of flowering. All possible cross combinations without reciprocals were made among the seven wheat genotypes for giving 21 F1 grain hybrids.

In 2013/14 season, the parental genotypes and their respective F1 21 hybrids were sown on 25th of November in randomized complete block design (RCBD) according to Montgomery (1997) with three replications.

In 2014/15 season, the parental genotypes and their respective 28 F2 crosses were sown on 29th November in randomized complete block design with three replications.

In both seasons of evaluation, 2013/14 and 2014/15 each plot consisted of two rows for F1 experiment in the first evaluation season 2013/14 , and six rows for F2 experiments in the second evaluation season (2014/15). Each row was three meters long and 30 cm apart. Plants row were 20 cm a part. Dry method of sowing was used in this concern. The other cultural practices of wheat crop growing were properly practiced as described by the ministry of agriculture. Data for the all studied traits were recorded on 10 and 60 individual guarded plants, chosen at random from each plot for F1 and F2, respectively.

The following characteristics were studied in the parents and their crosses in F1 and F2 generations.
1- Grain yield/plant (g).
2- Number of spikes/plant.
3- Number of grains/spike.
4- 1000-grain weight (g).
5- Straw yield/plant (g).
6- Biological yield/plant (g).
7- Harvest index (%).

The recorded data were analyzed according to Griffing (1956) diallel cross analysis designated as method 2 and model 1. The mathematical model for the combining ability analysis was as follows:

$X_{ij} = u + \hat{g}_i + \hat{g}_j + \hat{S}_{ij} + (1/bc)\sum_i k \sum_j eijkl$
Where, X_{ij} = 1,2, ,p
k = 1,2, ,b
L = 1,2, ,c
X_{ij} = the value of the cross between parent (i) and parent (j).
u = is the population mean.
$\hat{g}_i$ and $\hat{g}_j$ = are the general combining ability effects for the parents (i) and (j) respectively.
$\hat{S}_{ij}$ = is the specific combining ability effects (SCA) for the cross between the $(i)^{th}$ and $(j)^{th}$ parents.
e_{ijkl} = the environmental effect associated with the ijkl observation

RESULTS AND DISCUSSION

Analysis of variance and mean performance

Analysis of variance for all studied traits for F1 and F2 generations are presented in Table (2).

Mean squares for genotypes, parents, crosses were found to be significant for the seven traits except indicating wide diversity between the parental genotypes used in the present study for these traits. Significant variations among genotypes for grain yield and related traits were also reported by Ashoush (1996); Afiah *et al*. (2000); Ashoush *et al*. (2001); Darwish (2003); Abdel-Nour (2005); Fida *et al*. (2007); Saad *et al*. (2010); Attia *et al*. (2013); Ali and Sulaiman (2014) and Kandill (2016).

Parents vs.crosses were found to be significant for the seven traits except harvest index in both F1 and F2 generations. Mean squares for parents vs crosses are indication to average heterosis overall crosses were significant for all the studied traits which mean that there are desirable heterotic effects relative to mid-parent and better parent for these studied traits

The mean performance of the seven parental genotypes of wheat in both F1 and F2 generations are presented in Table (3). For grain yield/plant, line 1 was the superior parent (77.33, 71 g) for both evaluation seasons beside sham 6 in the second season. The crosses (P1 x P6), (P5 x P6) in F1 generation and the crosses (P4 x P5) and (P6 x P7) in F2 generation recorded the highest values of grain yield per plant, its values were 77.33; 77.50; 76.33 and 73.00 (g), respectively, while the lowest cross was (P1 x P2) which gave 56.00 and 51.00 (g) for F1 and F2 generations, respectively.

For number of spikes /plant, Line 2 (P7) followed by Sham 6 (P5) and Sahel 1 (P4) were the highest among parents these values were 19, 17.97 and 17.50 in the first evaluation season and 17.83, 16.83 and 16.50 in the second evaluation season. Meanwhile the parent Sids 12 (P1) owned the lowest number of spikes /plant (9.25 and 9.59) for both evaluation seasons. Cross (P2 x P7), (P4 x P7) and (P5 x P7) gave the highest number of spikes/plant (24.60, 24.43 and 24.17) in F1 generation and (P6 x P7), (P3 x P4) and (P3 x P7) crosses were the highest number of spikes/plant in F2 generation these values were (23.27, 22.83 and 22.67). Conversely, (P1 x P2) and (P1 x P3) crosses gave the lowest number of spikes /plant in the first evaluation season and (P1 x P2) cross in the second evaluation season.

Table (2). Means squares for all studied characters of seven wheat parents and their crosses in 2013/2014 (F1) and 2014/2015 (F2) seasons

s.o.v	d.f	Grain yield/plant (g)		No. of spikes/plant		No. of grains/spike		1000-grain weight (g)		Straw yield/plant (g)		Biological yield/plant (g)		Harvest index (%)	
		F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
Rep.	2	0.20	0.84	1.17	0.86	3.04	1.86	1.92	0.31	3.02	1.82	3.04	2.07	3.09	1.24
Genotypes	27	141.52**	22.24**	112.52**	85.55**	573.61**	259.76**	103.97**	117.18**	46.31**	16.22**	92.33**	83.31**	25.43**	5.38**
Parents (P)	6	311.37**	48.85**	246.23**	184.30**	961.90**	636.09**	208.98**	253.21**	44.67**	17.60**	145.16**	153.17**	37.31**	5.27**
Crosses	20	77.52**	14.66**	74.89**	59.61**	472.18**	159.21**	77.26**	81.85**	41.20**	14.46**	63.37**	58.11**	23.11**	5.42**
Pvs crosses	1	402.41**	14.05**	62.87**	11.64**	272.44**	12.73**	8.05**	7.56**	158.42**	43.06**	354.46**	168.30**	0.66	1.93
Error	54	0.94	6.10	0.32	0.42	0.39	0.61	0.62	0.49	7.57	11.42	6.21	5.87	0.59	3.08

** Indicate significance at 0.01 level of probability.

Concerning number of grains/spike, Sids 12 (P1) ranked the first parent which recorded 101.33 and 103.42 for both evaluation seasons. The cross (P1 x P6) had the highest number of grains/spike values (65.28 and 91.33) for both F1 and F2 generations beside (P1 x P3) cross in F1 generation (95.17). The highest number of grains /spike in these crosses could be attributed to superiority of the parent Sids 12 (P1) for this trait. (P2 x P7) and (P5 x P7) crosses gave the lowest value (71.33) and (71.80) for number of grains/spike in F1 generation and the cross (P5 x P7) and (P2 x P5) crosses had lowest values (70.50 and 70.53) for F2 generation.

Regarding 1000-grain weight the parental variety Sids 12 (P1) behaved as the highest values (57.84 and 56.93 g) for both evaluation seasons. While, Sahel 1 (P4) and Line 2 (P7) gave the lowest values (47.50 and 45.83 g), respectively for both evaluation seasons. The cross (P1 x P6) owned the highest 1000-grain weight values (53.50 and 52.33 g) for both F1 and F2 generations, respectively.

For straw yield /plant, Sham 6 (P5) had the highest values (88.33 and 90 g) for both evaluation seasons; meanwhile Gemmeiza 11 (P2) gave the lowest values (71 and 72.67 g) for both evaluation seasons. The cross (P3 x P6) behaved to be the first value of straw yield/plant (102.87 g) in F1 generation, crosses (P2 x P5), (P3 x P6) and (P6 x P7) were the highest values (98.50, 98 and 96.33 g) for F2 generation. The cross (P1 x P2) had the lowest values (71 and 72.67 g) of straw yield/plant in both F1 and F2 generations.

Concerning biological yield/plant, line 1 (P6) gave the highest values (165, 160.67 g) followed by Sham 6 (P5) which values were (161, 160 g), respectively for both evaluation seasons. The lowest values were given by Sids 12 (P1)(124.90 and (127.28) for both evaluation seasons. The cross (P3 x P6) showed the highest value (174.33 g) followed by the cross (P6 x P7) with insignificant difference which produced (173.67 g) for F1 generation. Regarding F2 generation, the highest biological yield/plant was (169.33 and 167.33 g) which owned to (P6 x P7) and (P3 x P6) crosses. The lowest values (127 and 123.67 g) were given by the cross (P1 x P2) for both generations F1 and F2, respectively.

As for harvest index, P3,P6 and P7 in the first evaluation season and P4, P7, P6 and P5 gave the highest values (47.30, 46.87 and 46.76 %) and (45.22, 44.79, 44.19 and 43.76 %) , while the lowest values (42.09 and 41.24) were given by Sids 12 (P1) and Gemmeiza 11 (P2) for the two respective evaluation seasons. The two crosses (P5 x P7) and (P1 x P3) in the F1 season and (P4x P5) in the F2 season gave the best values (48.11 and 47.30%) and (50.12 %) for harvest, respectively. In the other side, the lowest values (41.07, 41.23 and 41.66%) in F1 generation and (38.83%) in F2 generation were recorded by the crosses (P4 x P7), (P3 x P6) and (P2 x P4) for F1 generation and (P2 x P5) for F2 generation, respectively.

Table (3). Genotype mean performances for all studied characters of seven parents of wheat and their crosses among 2013/2014 (F1) and 2014/2015 (F2) seasons

genotypes	Grain yield/plant (g)		No. of spikes/plant		No. of grains/spike		1000-grain weight (g)		Straw yield/plant (g)		Biological yield/plant (g)		Harvest index (%)	
	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2
P1 (Sids 12)	52.57	53.22	9.25	9.59	101.33	103.42	57.84	56.93	72.33	73.12	124.90	127.28	42.09	41.81
P2 (Gemm.11)	56.00	51.00	15.63	13.00	88.83	80.00	51.27	49.60	71.00	72.67	127.00	123.67	44.11	41.24
P3 (Ĝiza168)	72.67	62.50	15.53	14.93	93.60	84.00	49.50	46.77	81.00	85.17	153.67	147.67	47.30	42.33
P4 (Sahel 1)	66.33	64.50	17.50	16.50	94.00	84.00	47.50	47.50	78.67	78.17	145.00	142.67	45.74	45.22
P5 (Sham 6)	72.67	70.00	17.97	16.83	90.17	87.00	52.00	48.33	88.33	90.00	161.00	160.00	45.13	43.76
P6 (Line 1)	77.33	71.00	16.33	14.57	95.17	91.33	53.50	52.33	87.67	89.67	165.00	160.67	46.87	44.19
P7 (Line 2)	67.33	64.33	19.00	17.83	88.37	81.00	49.07	45.83	76.67	79.33	144.00	143.67	46.76	44.79
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
1x2	56.00	51.00	15.63	13.00	90.17	80.00	51.27	49.60	71.00	72.67	127.00	123.67	44.11	41.24
1x3	72.67	62.50	15.53	14.93	95.17	84.00	49.50	46.77	81.00	85.17	153.67	147.67	47.30	42.33
1x4	66.33	64.50	17.50	16.50	88.37	84.00	47.50	47.50	78.67	78.17	145.00	142.67	45.74	45.22
1x5	72.67	70.00	17.97	16.83	90.17	87.00	52.00	48.33	88.33	90.00	161.00	160.00	45.13	43.76
1x6	77.33	71.00	16.33	14.57	95.28	91.33	53.50	52.33	87.67	89.67	165.00	160.67	46.87	44.19
1x7	67.33	64.33	19.00	17.83	88.37	81.00	49.07	45.83	76.67	79.33	144.00	143.67	46.76	44.79
2x3	67.33	64.67	21.43	19.17	79.97	75.50	40.83	41.00	88.33	84.67	154.00	149.33	43.26	43.31
2x4	61.37	58.33	19.43	18.83	80.27	80.17	41.33	37.50	85.97	86.33	147.33	144.67	41.66	40.33
2x5	70.33	62.50	22.00	21.67	73.83	70.53	43.73	43.40	92.00	98.50	160.33	161.00	43.33	38.83
2x6	71.83	69.00	20.83	18.50	74.33	73.83	46.60	48.50	96.17	91.67	168.00	160.67	42.77	42.95
2x7	67.17	66.00	24.60	21.17	71.33	71.83	40.33	42.00	80.50	78.00	147.67	144.00	45.04	45.84
3x4	70.97	68.27	21.77	22.83	81.10	80.43	40.93	39.67	80.70	79.07	151.67	147.33	46.80	46.34
3x5	72.03	70.43	22.00	20.83	79.27	77.93	43.50	42.33	95.30	94.57	167.33	165.00	43.06	42.69
3x6	72.13	69.33	21.97	21.17	74.83	73.77	45.27	45.00	102.87	98.00	174.33	167.33	41.23	41.45
3x7	67.93	66.67	22.17	22.67	74.60	72.60	41.00	40.43	84.73	82.33	152.67	149.00	44.51	44.76
4x5	72.90	76.33	22.03	20.50	77.93	75.83	43.60	45.33	90.77	76.00	163.67	152.33	44.55	50.12
4x6	71.10	70.00	22.14	20.17	78.93	75.50	44.33	44.67	92.90	87.00	163.33	157.00	43.36	44.59
4x7	69.00	69.00	24.43	21.00	78.17	71.93	40.93	40.60	99.00	91.67	168.00	160.67	41.07	42.96
5x6	77.50	71.00	22.50	21.43	73.67	73.67	47.27	44.67	86.17	89.67	163.67	160.67	47.37	44.19
5x7	73.43	69.10	24.17	21.93	71.80	70.50	45.67	44.17	79.23	84.23	152.67	153.33	48.11	45.08
6x7	73.93	73.00	23.60	23.27	73.50	74.33	43.50	42.33	99.73	96.33	173.67	169.33	42.58	43.12
Genotypes mean	68.84	66.42	20.53	19.61	80.00	77.24	45.18	44.50	85.72	84.94	154.38	151.35	44.54	43.87
L.S.D. at 5 %	1.32	3.37	0.77	0.89	0.85	1.07	1.07	0.96	3.08	4.61	3.40	3.30	1.05	2.39
L.S.D. at 1 %	1.58	4.03	0.92	1.06	1.01	1.28	1.29	1.14	3.69	5.52	4.07	3.96	1.26	2.86

E1: The first season of evaluation (2013/2014).
E2: The second season of evaluation (2014/2014).
F1: First generation (2013/2014)
F2: Second generation (2014/2015)

Combining ability

Analysis of variance for combining ability for F1 and F2 generations are presented in Table (4). Mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were found to be significant for all studied measurements for both F1 and F2 generations. It is evident that both additive and non-additive types of gene action were important parts for inheritance of these traits in F1 and F2 generations. High GCA /SCA ratio which largely exceeded the unity were detected for all traits. In F1 and F2 generations. Such results indicated the predominance of additive and additive x additive types of gene action in the inheritance of these traits. These results were in agreement with those found by Abdel-nour (2005).

General combining ability effects

General combining ability effects (ĝi) for individual parental genotype for all studied measurements in the two evaluation seasons (2013/2014) and (2014/2015) are presented in Table (5). Such results are being used to compare the average performance of each parent with other genotype and facilitate selection of parent for high yield and yield components.

For grain yield/plant in both seasons of evaluation, high significant negative (ĝi) effects were detected for Sids (P1) and Gemmeiza 11 (P2). Sahel 1 (P4) expressed high significant negative and positive (ĝi) effects, respectively for grain yield/plant in the first season and the second season of evaluation.

For the other parents, highly significant positive (ĝi) values for grain yield/plant were recorded for both seasons of evaluation expect Giza168 (P3) and Line 2 (P7) which expressed high significant (ĝi) effect for grain yield/plant in the first and second season of evaluation, respectively.

Regarding number of spikes /plant, highly significant positive GCA effects were given by Giza 168 (P3), Sahel 1 (P4), Sham 6 (P5), Line 1 (P6) and Line 2 (P7) for the first and the second seasons of evaluation which means that these parents appeared to be good combiners for this trait. The other two parents gave highly significant negative (ĝi) effects for this trait in both seasons of evaluations.

Concerning number of grain/spike, the parental genotype Sids 12 (P1) followed by Giza168 (P3) and sahel 1 (P4) were the best combiners for number of grains per spike, they gave the highest significant positive (ĝi) effects for both seasons of evaluation, except (P4) in the second evaluation season.

Table (4). Mean squares of general and specific combining abilities from diallel cross analysis of wheat for the studied traits in F1 and F2 generations

s.o.v	d.f	Grain yield/plant (g)		No.of spikes/plant		No. of grains/spike		1000-grain weight (g)		Straw yield/plant (g)		Total yield of plant (g)		Harvest index (%)	
		F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
Genotypes	27	141.52**	22.24**	112.52**	85.55**	573.61**	259.76**	103.97**	117.18**	46.31**	16.22**	92.33**	83.31**	25.43**	5.38**
GCA	6	444.72**	80.99**	467.96**	360.29**	2456.10**	1004.54**	452.57**	462.12**	10.4.27**	38.01**	283.01**	276.13**	29.44**	10.97**
SCA	20	57.64**	5.72**	11.52**	7.40**	37.54**	49.32**	4.59**	19.55**	31.24**	10.49**	39.74**	29.63**	25.50**	3.97**
GCA/SCA		7.72	14.15	40.63	48.69	65.42	20.37	98.61	23.63	3.34	3.62	7.12	9.32	1.15	2.76
Error	54	0.31	2.3	0.11	0.14	0.13	0.20	0.21	0.16	1.70	3.81	2.07	1.96	0.20	1.03

** indicate significance at 0.01 level of probability.
GCA refers to general combining ability.
SCA refers to specific combining ability.

Table (5). Estimation of general combining ability (GCA) effects for wheat seven parents from two evaluation seasons (2013/14) and (2014/15)

genotypes	Grain yield/plant (g)		No. of spikes/plant		No. of grains/spike		1000-grain weight (g)		Straw yield/plant (g)		Biological yield/plant (g)		Harvest index (%)	
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
P1 (Sids 12)	-3.69**	-4.76**	-4.86**	-4.89**	12.35**	10.23**	6.35**	5.58**	-6.42**	-4.43**	-9.95**	-9.19**	0.42**	-0.58*
P2 (Gemm.11)	-6.12**	-6.47**	-0.65**	-1.04**	-3.36**	-2.78**	-1.57**	-1.22**	-2.52**	-2.07**	-8.89**	-8.54**	-1.68**	-1.93**
P3 (Giza168)	1.85**	-0.05	0.53**	1.08**	0.30**	0.63**	-2.04**	-2.09**	0.32	1.55**	2.07**	1.50**	0.67**	-0.41
P4 (Sahel 1)	-0.58**	0.99**	0.45**	0.58**	1.25**	-0.81**	-2.34**	-2.01**	-0.62	-3.23**	-1.11**	-2.24**	0.05	1.35**
P5 (Sham 6)	3.35**	4.19**	1.20**	1.26**	-3.48**	-2.19**	0.68**	0.51**	3.19**	3.16**	6.48**	7.35**	0.30**	0.65**
P6 (Line 1)	5.18**	5.05**	0.79**	0.69**	-2.51**	-0.94**	1.59**	1.71**	7.59**	6.82**	12.78**	11.87**	-0.27**	-0.08
P7 (Line 2)	0.01	1.05**	2.55**	2.32**	-4.72**	-4.14**	-2.66**	-2.49**	-1.54**	-1.81**	-1.37**	-0.76*	0.52**	1.00**
LSD at 5% ĝi	0.29	0.73	0.17	0.19	0.18	0.23	0.23	0.21	0.67	1.01	0.74	0.72	0.23	0.52
LSD at 1% ĝi	0.35	0.88	0.20	0.23	0.22	0.28	0.28	0.25	0.80	1.20	0.89	0.86	0.27	0.62
LSD at 5% ĝi- ĝi	0.44	1.12	0.26	0.30	0.28	0.36	0.36	0.32	1.03	1.54	1.13	1.10	0.35	0.80
LSD at 1% ĝi- ĝi	0.53	1.34	0.31	0.35	0.34	0.43	0.43	0.38	1.23	1.84	1.36	1.32	0.42	0.95

*and ** indicate significance at 0.05 and 0.01 levels of probability respectively.

Highly negative significant (ĝi) effects for number of grain/spike were detected by Gemmeiza 11 (P2), Sham 6 (P5), line 1 (P6) and Line 2 (P7) for the two seasons of evaluation.

For 1000-grain weight, three parental genotypes, Sids 12 (P1), Line 1 (P6) and Sham 6 (P5) expressed high significant positive (ĝi) effects for both evaluation seasons. The result indicates that the three genotypes could be considered as good combiner for this trait. While, Gemmeiza 11 (P2), Giza168 (P3), Sahel 1 (P4) and Line 2 (P7) showed highly significant negative (ĝi) effects for 1000-grain weight in both seasons of evaluation.

Considering the estimate of GCA effects for straw yield /plant, the parental genotypes Sham 6 (P5) and Line 1 (P6) gave the desirable (ĝi) effects in the two evaluation seasons, while Giza168 (P3) gave the desirable (ĝi) effects for straw yield/plant in the second season of evaluation. The other parental genotypes gave undesirable (ĝi) effects for straw yield/plant in one or both seasons of evaluation.

For biological yield/plant, the three parental genotypes Giza168 (P3), Sham 6 (P5) and Lina 1 (P6) expressed highly significant positive (ĝi) effects for both seasons of evaluation.

For harvest index, the two parental genotypes Sham 6 (P5) and Line 2 (P7) expressed highly significant positive (ĝi) effects for both seasons of evaluation, P1 and P3 in the first season and P4 in the second season showed desirable (ĝi) effect for that trait,while Gemmeiza 11 (P2) showed highly significant negative (ĝi) for harvest index in both evaluation seasons.

Specific combining ability

Specific combining ability effects (ŝij) of parental combinations computed for all studied traits in F1 and F2 generations are shown in Table (6). Ten and six crosses exhibited positive and high significant (SCA) effects for grain yield /plant in F1 and F2 generations, respectively. Such results indicate that these cross could be considered as good crosses for developing line to high grain yield.

For F1 and F2 generations, four crosses exhibited positive and high significant (ŝij) effects for number of spikes /plant. The cross (Sids 12 x Sahel 1) had the highest (ŝij) effect.

From the same Table, it could be noticed that the four crosses (Sids 12 x Line1), (Gemmeiza 11 x Sahel 1) and (Giza168 x Sham 6) are considered to be promising hybrids for improving number of grains per spike as they showed highly significant positive (ŝij) effects for F1 and F2 generations.

Table (6). Estimate of specific combining ability effects" ŝij " for the studied twenty one crosses of wheat in F1 and F2 generations

Genotypes	Grain yield/plant (g)		No. of spikes/plant		No. of grains/spike		1000-grain weight (g)		Straw yield/plant (g)		Biological yield/plant (g)		Harvest index (%)	
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
Sids 12 x Gemmeiza 11	-3.03**	-4.18**	0.61**	-0.67**	-0.34	-4.69**	1.31**	0.74**	-5.78**	-5.78**	-8.54**	-9.96**	0.83**	-0.12
Sids 12 x G168	5.67**	0.90	-0.66**	-0.87**	0.77**	-4.10**	0.02	-1.23**	1.37	3.10*	7.17**	4.00**	1.68**	-0.55
Sids 12 x Sahel 1	1.77**	1.86	1.38**	1.20**	0.22	-2.66**	-1.68**	-0.57	-0.02	0.89	1.69	2.74**	0.74*	0.58
Sids 12 x Sham 6	4.17**	4.16**	1.10**	0.86**	1.11	1.72**	-0.20	-2.26**	5.84**	6.33**	10.09**	10.48**	-0.13	-0.18
Sids 12 x Line 1	7.01**	4.29**	-0.12	-0.84**	5.14**	4.80**	0.39	0.54	0.78	2.34	7.80**	6.63**	2.18**	0.99
Sids 12 x Line 2	2.18**	1.63	0.79**	0.80**	0.55*	-2.33**	0.21	-1.76**	-1.09	0.63	0.95	2.26*	1.28**	0.50
Gemm 11 x G168	2.77**	4.77**	1.02**	-0.48	3.03**	0.42	-0.73*	-0.19	4.81**	0.24	6.44**	5.02**	-0.27**	1.77**
Gemm 11 x Sahel 1	-0.77	-2.60**	-0.90**	-0.31	2.38**	6.53**	0.06	-3.77**	3.39**	6.69**	2.96**	4.09**	-1.26**	-2.96**
Gemm 11 x Sham 6	4.26**	-1.64	0.92**	1.84**	0.67**	-1.76**	-0.55	-0.39	5.61**	12.47**	8.37**	10.83**	0.17	-3.76**
Gemm 11 x Line 1	3.94**	4.00**	0.17	-0.75**	0.20	0.32	1.40**	3.51**	5.39**	1.98	9.74**	5.98**	0.17	1.09
Gemm 11 x Line 2	4.44**	5.00**	2.17**	0.28	-0.59*	1.52**	-0.61	1.21**	-1.15	-3.06**	3.55**	1.94	1.65**	2.90**
G168 x Sahel 1	0.86*	0.91	0.26	1.56**	-0.45	3.37**	0.14	-0.74**	-4.73**	-4.19**	-3.67**	-3.28**	1.54**	1.52*
G168 x Sham 6	-2.00**	-0.12	-0.25	-1.12**	2.44**	2.26**	-0.31	-0.59	6.07**	4.91**	4.40**	4.79**	-2.45**	-1.43
G168 x Line 1	-3.73**	-2.08	0.12	-0.21	-2.96**	-3.16**	0.54	0.87**	9.24**	4.69**	5.11**	2.61**	-3.71**	-1.94**
G168 x Line 2	-2.76**	-0.75	-1.44**	-0.34	-0.98**	-1.13**	0.53	0.51	0.23	-2.35	-2.41*	-3.10**	-1.22**	0.29
Sahel 1 x Sahm 6	1.29**	4.74**	-0.14	-0.95**	0.16	1.60**	0.09	2.33**	2.47**	-8.87**	3.92**	-4.13**	-0.34	4.24**
Sahel 1 x Line 1	-2.33**	-2.46*	0.37	-0.71**	0.19	0.01	-0.10	0.46	0.21	-1.53	-2.71**	-3.98**	-0.96**	-0.55
Sahel 1 x Line 2	0.73	0.55	0.90**	-1.51**	1.63**	-0.35	0.76**	0.60	15.44**	11.77**	16.11**	12.31**	-4.04**	-3.26**
Sham 6 X Line 1	0.13	-4.66**	-0.01	-0.12	-0.35	-0.44	-0.18	-2.06**	-10.33**	-5.25**	-9.97**	-9.91**	2.79**	-0.25
Sham 6 X Line 2	1.23**	-2.55*	-0.11	-1.25**	-0.01	-0.41	2.48**	1.64**	-8.13**	-2.06	-6.82**	-4.61**	2.75**	-0.44
Line 1 x Line 2	-0.09	0.48	-0.26	0.65*	0.73**	2.17**	-0.60	-1.39**	7.97**	6.39**	7.89**	6.87**	-2.22**	-1.67*
LSD at 5% $\hat{s}_{ij}$	0.84	2.14	0.49	0.56	0.54	0.68	0.68	0.61	1.95	2.92	2.16	2.10	0.67	1.52
LSD at 1% $\hat{s}_{ij}$	1.00	2.56	0.58	0.67	0.64	0.81	0.82	0.73	2.34	3.50	2.58	2.51	0.80	1.82
LSD at 5% $\hat{s}_{ij} - \hat{s}_{ik}$	1.25	3.17	0.73	0.84	0.80	1.00	1.01	0.90	2.90	4.34	3.20	3.11	0.99	2.25
LSD at 1% $\hat{s}_{ij} - \hat{s}_{ik}$	1.49	3.80	0.87	1.00	0.96	1.20	1.21	1.08	3.48	5.20	3.84	3.73	1.18	2.70
LSD at 5% $\hat{s}_{ij} - \hat{s}_{kl}$	1.17	2.97	0.68	0.78	0.75	0.94	0.95	0.84	2.72	4.06	3.00	2.91	0.92	2.11
LSD at 1% $\hat{s}_{ij} - \hat{s}_{kl}$	1.40	3.56	0.81	0.94	0.89	1.13	1.13	1.01	3.25	4.87	3.59	3.49	1.11	2.53

*and ** indicate significance at 0.05 and 0.01 levels of probability respectively.

Three crosses exhibited significant positive (ŝij) for 1000-grain weight for F1 and F2 generations. (Sids12 x Gemmeiza11), (Gemmeiza11 x Line1) and (Sham 6 x Line 2) crosses had the highest (ŝij) effect for 1000-grain weight in the two generation.

Regarding straw yield /plant, seven crosses exhibited highly significant desirable (ŝij) effects in both generations. The crosses (Sahel 1 x Line 2) and (Line 1 x Line 2) were the highest crosses for (ŝij) effects for straw yield/plant in F1 and F2 generations.

Concerning biological yield, ten crosses exhibited highly significant positive (ŝij) effects for F1 and F2 generations. The cross (Sahel 1 x Line 2) gave the highest (ŝij) effect for biological yield/plant in both generations.

For harvest index, the crosses (Gemmeiza 11 x Line 2) and (Ĝiza168 x Sahel1) exhibited significant and positive (SCA) effects in F1 and F2 generations for that trait.

CONCLUSION

Previous results revealed that there was significant genotypic variation among the genotypes for all studied traits. Line 1 (P6) could be as donner parent for the improvement of grain yield and biological yield. Sids 12 cultivar (P1) gave the highest grain yield per spike and the highest 1000-grain weight. (Sids 12 x Sham 6) cross gave highest grain yield, number of spikes /plant and 1000-grain weight.

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الملخص العربى

تحليل المحصول ومكوناته لهجن قمح الخبز

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**محطة بحوث إيتاى البارود- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية.

أقيمت هذه الدراسة بمزرعة محطة البحوث الزراعية بإيتاى البارود خلال المواسم ٢٠١٢/١٣ و ٢٠١٣/١٤ و ٢٠١٤/١٥ وتهدف الدراسة الى تقييم بعض التراكيب الوراثية الابويه لقمح الخبز والهجن المستقيمه بينها فى الجيلين الأول والثانى وكانت الصفات المدروسة هى: محصول الحبوب/النبات، عدد السنابل/النبات، عدد الحبوب/السنبلة، وزن الألف حبة، محصول القش/النبات، المحصول البيولوجى/النبات، دليل الحصاد.

وتشير النتائج الى ان التباين الراجع للتراكيب الوراثية الابويه والهجن المستقيمه بينهم، والتفاعل بين الأباء والهجن كان معنوياً لغالبية الصفات فى الجيلين الأول والثانى. ووجد أن التباين الراجع الى القدرة العامه (GCA)

والخاصه على الإتلاف (SCA) كان معنوياً فى الصفات تحت الدراسه وكانت النسبة بين القدرة العامة / القدرة الخاصة على الإئتلاف أعلى من الوحده لكل الصفات المدروسه. أظهرت السلالات الأبوية سدس ١٢ أعلى قدرة عامة على التآلف معنوية ومرغوبة لصفات محصول الحبوب/النبات و عدد الحبوب /السنبلة ووز الالف حبة فى كل من الجيلين الأول والثانى.

فيما يتعلق بصفه محصول القش/النبات فإن التركيب الوراثى شام ٦ اظهر اعلى قدرة عامة على التآلف معنوية ومرغوبه فى موسمى التقييم (٢٠١٣/٢٠١٤) ، (٢٠١٤/٢٠١٥). أظهر الهجين (سدس ١٢ x سلاله ١) أعلى قدرة خاصة على الإئتلاف موجبه ومرغوبه لصفتى محصول الحبوب/النبات وعدد الحبوب/السنبلة. أما الهجين (سدس ١٢ x ساحل ١) أعطى أعلى قدرة خاصة على الإئتلاف موجبة ومرغوبه لصفة عدد السنابل/النبات فى كل من الجيلين الأول والثانى.