COMBINING ABILITY ESTIMATES FOR SOME AGRONOMIC, YIELD COMPONENTS AND BLAST REACTION TRAITS IN RICE (*ORYZA SATIVA* L.)

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ABSTRACT

Combining ability analysis was carried out in rice, through A 6 x 6 diallel set analysis (excluding reciprocals) for some agronomic and yield components traits as well as blast reaction at the Experimental Farm of Sakha Agricultural Research station, Sakha, Kafr El-Sheikh, Egypt during 2015 and 2016 summer seasons. The ratio of variances due to general and specific combining abilities (ó^2 GCA / ó^2 SCA) was found to be lower than unity for all studied characters, except 1000-grain weight, suggesting greater importance of non- additive genetic variance (over dominance or epitasis) in the inheritance of these characters. Obviously, highly significant and positive estimates of (GCA) effects were recorded for chlorophyll content in Large stigma rice variety, indicating that this entry could be used to improve such trait. Regarding to blast reaction, the rice varieties; Giza 177, Giza 179 and Giza 178 exhibited significant and highly significant negative values of GCA effects, while Large stigma and Baldo varieties showed the positive values of GCA effects. The results proved that the rice variety Large stigma considered as good combiner for improving the earliness, shortness and high chlorophyll content. Also, estimates of GCA effects showed that the parents, Giza 177, Giza 178 and Giza 179 were found to be good general combiners for blast reaction. Moreover, Giza 178 and Giza 179 were the best general combiners for grain yield/plant.

In addition, Blast reaction showed that five crosses were found to be high or highly significant and negative estimates of SCA, their estimated values were ranging from -0.70 for Giza 177 x Large stigma to -0.83 for Giza 178 x Large stigma. The crosses which gave negative significant values could be utilized in rice breeding program to improve this trait. Moreover, 5 crosses out of 15 combinations possessed significant desirable SCA effects for grain yield / plant involving two kinds of combinations between the parents of high x high GCA effects, such as SKC23819-192 x Baldo, suggesting that additive x additive type of gene action play an important role in the inheritance of this trait.

From the foregoing results, the crosses Giza 177 x Baldo, Giza 177 x Large stigma, Giza 178 x Large stigma and SKC23819-192 x Baldo could be utilized in rice breeding program to improve yield and its components and blast resistance traits.

Key Words: rice, grain weight, blast reaction, grain yield, combining ability, heritability.

INTRODUCTION

Rice (*Oryza sativa*) is one of the important a cereal grain, and most widely consumed staple food for a large part of the world's human population **(FAOSTAT, 2015).** Also, is the most important grain with regard to human nutrition and caloric intake, providing more than one fifth of the calories consumed worldwide by humans **(Smith, Bruce 1998).** The grain yield in rice depending on different components, including 1000-grain weight which an important character to study not only because of its contribution to yield, but also because of its influence in rice marketing and trade **(Gupta *et al*., 2006).**

Grain size is usually evaluated by two criteria: grain weight and shape **(Tan *et al*., 2000; Fan *et al*., 2006).** Grain weight and grain shape (length, width, length/width ratio) are positively correlated characters **(Fan *et al*., 2006)**. However, the economic way to get high yielding varieties it should have good grain shape, nutritional value, disease resistance, and stress tolerance **Tan, *et al*., (2000).** Study the inheritance and nature of relationships between grain length, grain shape and 1000-grain weight by **(Mzengeza et al., 2010).** Most of these ergonomically important traits are known to be genetically controlled by multiple genes **Tan, *et al*., (2000)**.

Combining ability is defined as the ability of a parent line in hybrid combinations (**Kambal and Webster, 1965).** It plays an important role in selecting superior parents for hybrid combinations and in studying the nature of genetic variation **(Duvick, 1999).** It is a powerful method to measure the nature of gene action involved in quantitative traits **(Baker, 1978).** The authors defined GCA as the average performance of a line in hybrid combinations, while SCA as those instances in which certain hybrid combinations are either better or poorer than would be expected of the average performance of the parent inbred lines included. For random individuals, GCA is associated with additive effects of the genes, while SCA is related to dominance and epistatic effects (non-additive effects) of the genes **(Sprague and Tatum, 1942).** GCA effects represent the fixable component of genetic variance, and are important to develop superior genotypes. SCA represents a non-fixable component of genetic variation, it is important to provide information for hybrid performance. The GCA/SCA ratio is studied as parameter of the genetic variability in a diallel analysis. It estimates the type of gene action, which controls a particular characteristic **(Quick, 1978; Sayed, 1978).** When the ratio is high, it means the effect of the additive genes is prevalent. If the ratio is lower than one, it means the effect of nonadditive genes is prevalent in determining a particular character. If GCA variance is higher than

SCA variance, the greater is the magnitude of additive genetic effects. Otherwise, the non-additive or dominant genetic variances are prevalent **(Baker, 1978).** The closer this ratio is to unity the greater the magnitude of additive genetic effects. Success of breeding [programs depends on the magnitude of genetic variability and the extent to which the advantageous characters**.** Therefore, the study of genetic variability in rice is not only essential for selecting variable genotypes and predicting that affect of selecting best genotypes but it will also aid breeders in simultaneous improvement of characters through selection **(Patil, *et al*., 1993).**

The combining ability analysis was done according to **Griffing's (1956 b)**, Model 1, Method 2, where parents, and one set of F1's were included to estimate the effects of general (GCA) and specific (SCA) combining ability and variance components. The GCA: SCA ratio was estimated to study the performance of the effects and to measure the relative importance of additive gene or non-additive gene effects **(Singh and Chaudhary, 1979)**. The objectives of this investigation, therefore, were to study the genetic variability for some agronomic, yield components and blast reaction traits.

MATERIALS AND METHODS

This study was conducted at Sakha Agricultural Research station, Sakha, Kafr El-Sheikh, Egypt during 2015 and 2016 growing seasons. Combining ability effects and genetic components were studied in six rice parents and their $F1_s$ crosses, using six parents viz. Giza 177, Giza 178, Giza 179, SKC 23819-192, Baldo and Large Stigma (Table 1).

Table (1): parentage, origin and type of the six genotypes used in the experiment

parents	Type	Parentage	Origin
Giza 177	Japonica	(Giza 171/Yu mji No.1//piNo.4)	Egypt
Giza 178	Indica-Japonica	Giza175 / Milyang49	Egypt
Giza 179	Indica-Japonica	(Gz1368 / IRAT112)	Egypt
SKC 23819-192	Japonica	(M202/Sakha102)	Egypt
Baldo	Japonica	Introduced line	Italy
Large stigma	Indica-Japonica	Introduced line	China

The six parental varieties in this study were sown in the summer season of 2015 in three sowing dates, at 15 days intervals to overcome the difference of heading date among the parental varieties. After 30 days from sowing, seedlings of the parents were transplanted to the experimental field in three rows, of 5 meters long and 20 x 20 cm apart between plants and rows.

A half diallel cross was conducted among the six parents in 2015 growing season to produce 15 F_1 cross. The six parental varieties and the resulting 15 F_1 crosses were evaluated and arranged in a Randomized Complete Block Design (RCBD) experiment with three replications in 2016 growing season. Each replication contained 21genotypes, one row per each genotypes, each row had 25 individual plants. Data were collected for following agronomic traits; days to maturing (days), plant height (cm), number of panicles/plant, Chlorophyll content (SPAD), panicle length (cm), number of filled grains/panicle, 1000-grain weight (gm), grain yield /plant (g) and blast reaction. Data were analyzed according to (**Griffing analysis, 1956**), method-2, model-1. This is a fixed model and was considered most appropriate as its all requirements were met by the experiment. Variances due to general and specific combining ability were estimated. All recommended cultural practices were followed to obtain normal growth of the crop according to **RRTC (2015).**

RESULTS AND DISSECTION

Mean performance:

Mean performance of studied characters for parents and their F_1 crosses are presented in Table (2). Regarding to number of days to heading, the rice variety Large Stigma and cross (Baldo x Large stigma) showed the lowest values 81 and 88 days, respectively, while the rice genotypes; Giza 178, Giza 177 x Giza 178, Giza 177 x Giza 179, Giza 178 x Giza 179 and Giza 179 x Baldo recorded the highest values of number of days to heading. For plant height, Large stigma rice variety gave the shortest plant 86.3cm while, Giza 178 and the hybrid combinations; SKC23819-192 x Baldo, Giza 177 x SKC23819-192 and Giza 177 x Baldo gave the tallest plants 105, 121.2, 117 and 115.2 cm, respectively. Concerning chlorophyll content, the rice genotypes, Giza 178, large stigma, Baldo x Large stigma, SKC23819-192x Large stigma, SKC23819-192 x Baldo and Giza 179 x Baldo showed the highest values of chlorophyll content in their flag leaf. On the other hand, Baldo and SKC23819-192 exhibited the lowest values.

The rice varieties Baldo and Large stigma were susceptible to blast disease, while the other rice genotypes including parents and their F_1 crosses were resistant to rice blast. The rice varieties; Giza 179, Giza 178 and crosses (Giza 177 x SKC23819-192) and (SKC23819-192 x Baldo) recorded the highest values of number of panicles plant/plant. While, Large stigma and Baldo showed the lowest values. For panicle length, Baldo and (Giza 178 x SKC23819-192) gave the longest panicle. On the other hand, (Giza 177 x Giza 178) gave the shortest one. Regarding to number of filled grains panicle/plant, (Giza 177 x Large stigma) and (Giza 177 x Baldo) exhibited the highest values 198 and 191, while Large stigma recorded the lowest value 118. The genotypes; Baldo, SKC23819-192, Large stigma, (Baldo x Large stigma) and (SKC23819-192 x Baldo) showed the highest values of 1000-grain weight 37.2, 35.4, 34.7, 35.7 and 33.6g, respectively. While, Giza 178 recorded the lowest value (21.2g).

Table (2): Mean performance of parents and their F_1's crosses for all studied traits during 2016 season

Genotypes	Days to heading (day)	Plant height (cm)	Chlorophyll content (SPAD)	Number of panicles/ Plant	Panicle length (cm)	Number of Filled grains/ panicle
Giza 177	94	101.5	43.8	20	20.2	125
Giza 178	104	105.7	47.3	23	22.2	160
Giza 179	92	99	45.4	24	23.3	170
SKC 23819-192	99	102	38.2	21	23.3	161
Baldo	98	97.2	36.4	17	24.3	138
Large stigma	81	86.3	48.5	15	21.4	118
Giza 177 x Giza 178	103	96.3	42.6	24	17.8	123
Giza 177 X Giza 179	102	99.5	44.5	23	20.5	123
Giza 177 X SKC 23819-192	92	117	50.9	25	23.2	177
Giza 177 X Baldo	98	115.2	48	24	23.4	191
Giza 177 X Large stigma	102	111.2	44.6	24	22.4	198
Giza 178 X Giza 179	101	98.8	42.8	23	21.3	141
Giza 178 X SKC 23819-192	96	105	44.5	25	26	112
Giza 178 X Baldo	95	94.7	42.5	23	20.3	136
Giza 178 X Large stigma	100	95.6	43.4	22	21.4	146
Giza 179 X SKC 23819-192	96	113.9	45.8	22	22.8	130
Giza 179 X Baldo	101	101	52.4	22	22.4	179
Giza 179 X Large stigma	92	102.6	48.7	23	20.9	166
SKC 23819-192 x Baldo	96	121.2	52.2	25	25.2	158
SKC 23819-192 x Large stigma	92	103.2	52.7	23	22.3	111
Baldo x Large stigma	88	96.4	53.7	24	23.3	135
L.S.D. at 0.05%	1.49	1.31	1.34	1.57	0.77	5.97
0.01%	2	1.76	1.8	2.1	1.03	7.99

Table (2): Continued

Genotypes	Number of Filled grains/ panicle	1000-grain weight (g)	Grain yield/ plant (g)	Grain length (mm)	Grain width (mm)	Grain shape (mm)	Blast reaction
Giza 177	125	28.1	36.4	7.6	3.3	2.3	2
Giza 178	160	21.2	45.4	7.6	3	2.5	2
Giza 179	170	27.5	45.4	7.9	3.2	2.8	2
SKC 23819-192	161	35.4	44.8	9.8	3.8	2.6	2
Baldo	138	37.2	33.3	10	4	2.5	4
Large stigma	118	34.7	30.5	9.5	3.5	2.7	4
Giza 177 x Giza 178	123	26.7	61.3	8.2	3.6	2.3	1
Giza 177 X Giza 179	123	28	51	8.5	3.8	2.2	1
Giza 177 X SKC 23819-192	177	31.1	54	7.8	3.8	2.1	2
Giza 177 X Baldo	191	28	68	7.6	3.5	2.2	1
Giza 177 X Large stigma	198	27.3	73.7	8	3.7	2.2	1
Giza 178 X Giza 179	141	27.8	51	8.4	3.7	2.2	2
Giza 178 X SKC 23819-192	112	25.3	76.7	8.4	3.8	2.2	2
Giza 178 X Baldo	136	26.6	64.3	8	3.5	2.3	1
Giza 178 X Large stigma	146	27.1	68	8.3	3.7	2.3	1
Giza 179 X SKC 23819-192	130	29	52.3	8.5	3.6	2.4	1
Giza 179 X Baldo	179	28.3	65	7.9	3.6	2.3	2
Giza 179 X Large stigma	166	28	51	7.9	3.5	2.3	1
SKC 23819-192 x Baldo	158	33.6	74.7	8.3	3.5	2.4	1
SKC 23819-192 x Large stigma	111	32.9	52.9	8.4	3.5	2.4	2
Baldo x Large stigma	135	35.7	47.3	8.5	3.6	2.4	3
L.S.D. at 0.05%	5.97	0.75	3.06	0.21	0.17	0.18	1.01
0.01%	7.99	1	4.09	0.28	0.23	0.24	1.34

Concerning grain yield plant/plant, the genotypes Giza 178 x SKC23819-192, SKC23819-192 x Baldo, and Giza 177 x Large stigma gave the highest values 76.7, 74.7 and 73.7 g plant/plant. On the other hand Large stigma and Baldo recorded the lowest values of grain yield plant/plant 30.5 and 33.3 g, respectively. The results obtained are in agreement with that reported by **Ramalingam *et al.* (1993).**

The rice varieties; Giza 177, Giza 178 and Giza 179 recorded the lowest values for grain length and grain shape traits, while, SKC23819-192 and Baldo gave the highest values for grain width trait. In addition, the crosses (Giza 177 x SKC23819-192) and (Giza 177 x Baldo) recorded the lowest values and desirable of grain length, while, (Giza 177 x Giza 179), (Giza 177 x SKC23819-192) and (Giza 178 x SKC23819-192) gave the highest values for grain width trait. On the other hand, (Giza 177 x SKC23819-192) and (Giza 177 x Baldo) gave the lowest values for grain shape trait.

Analysis of Combining ability:

Estimates of both general (GCA) and specific combining ability (SCA) variances for studied characters are presented in Tables (3). Both general and specific combining ability variances were found to be highly significant for all characters, indicating the importance of both additive and non-additive genetic variance in determining the inheritance of the studied characters i.e. no. of days to heading, plant height, chlorophyll content, blast reaction, number of panicles plant/plant, panicle length, number of filled grains panicle/plant, 1000-grain weight and grain yield plant/plant.

Table (3): Analysis of variance for all studied traits of six rice parents and F_1 crosses of rice

S.O.V.	D.f	Days to heading (day)	Plant height (cm)	Chlorophyll content (SPAD)	Number of panicles/ plant	Panicle length (cm)	Number of Filled grains/ panicle
Rep.	2	0.08	2.08	1.74	0.14	0.24	0.49
Genotypes	20	93.16**	217.39**	64.75**	19.25**	10.10**	2025.75**
Parents	5	191.63**	133.99**	72.48**	37.25**	6.60**	1379.33**
Crosses	14	59.92**	227.88**	51.61**	3.23*	11.97**	2393.65**
P. vs C (H)	1	66.05**	487.52**	210.08**	153.52**	0.81*	107.30**
Error	40	0.82	0.63	0.67	0.90	0.22	13.12
GCA	5	58.37**	107.34**	11.96**	5.93**	6.36**	243.88**
SCA	15	21.94**	60.83**	24.79**	6.57**	2.35**	819.04**
Error term	40	0.27	0.21	0.22	0.30	0.10	4.37
GCA/SCA ratio	---	0.33	0.22	0.06	0.11	0.34	0.04

*, ** significant at 0.05 and 0.01 levels, respectively.

The relative importance of each variance was determined using GCA /SCA ratio of mean squares. The GCA /SCA ratio was found to be lower than unity for all studied characters except 1000-grain weight, suggesting greater importance of non- additive genetic variance (over dominance or epitasis) in the inheritance of these characters. The results obtained are in agreement with that reported by **Ramalingam,**

***et al.* (1993), Bansal *et al*. (2000) and Sharam, Mani (2001)** and **El-Malky and Elamawi (2013)** stated that the non-additive genetic variance is more important for the inheritance of number of days to heading and plant height. While GCA/SCA ratio was greater than unity for 1000-grain weight suggesting greater importance of additive genetic variance in the inheritance of this character, then, it could be concluded that selection procedures based on the accumulation of additive effect would be successful in improving these traits. The results obtained are in agreement with that reported by **Hammoud (1996), EL-Refaee (2002), EL-Abd *et al.* (2003), El-Mowafi (2003)** and **Kolom *et al.* (2014).**

Table (3): Continued

S.O.V.	D.f.	1000-grain weight (g)	Grain yield/ plant (g)	Grain length (mm)	Grain width (mm)	Grain shape (mm)	Blast reaction
Rep.	2	0.33	2.84	0.01	0.00	0.01	0.21
Genotypes	20	48.10**	538.52**	1.38**	0.16**	0.11**	1.95**
Parents	5	112.84**	135.89**	3.96**	0.46**	0.10**	3.78**
Crosses	14	25.83*	298.89**	0.25*	0.04*	0.03*	0.89*
P.VsC (H)	1	35.61**	5906.41**	4.16**	0.29**	1.10**	7.55**
Error	40	0.21	3.43	0.02	0.01	0.01	0.37
GCA	5	49.60**	62.11**	0.74**	0.05*	0.04*	1.10**
SCA	15	4.83*	218.63**	0.36*	0.06**	0.03*	0.50*
Error	40	0.07	1.14	0.01	0.00	0.00	0.12
GCA/SCA ratio	---	1.30	0.03	0.26	0.12	0.16	0.32

*, ** significant at 0.05 and 0.01 levels, respectively.

General Combining Ability Effects (ĝi):

Estimates of the general combining ability effects of the individual parental genotypes for vegetative traits are given in Tables (4). Highly significant and positive **(ĝi)** were observed for the chlorophyll content, number of panicles/plant, panicle length, number of filled grains/panicle, 1000-grain weight and grain yield/plant while, highly significant and negative values were recorded for no. of days to heading, plant height and blast reaction which are desirable for improvement of these traits in breeding programs since the low mean values are the target of breeder. The results obtained are in agreement with that reported by and **El-Malky and Elamawi (2013), Quaqua *et al.* (2015)** and **Owere *et al.* (2016)** also **Gangopadhyay and Mohanty (1983)** also reported the data on resistance to Pyricularia oryzae from a seven-parent diallel, including reciprocals, indicated that the resistant varieties were good general combiners in crosses with one moderately resistant and three susceptible varieties. With respect to no. of days to heading, the rice variety Large stigma showed highly significant and negative general combining ability effects, indicating that this parent could be considered as good combiner for the improvement of this trait. Regarding plant height, the rice genotypes, Large stigma, Giza 178 and Giza 179 showed highly significant and negative general combining ability effects with values -4.93, -2.42 and -0.90 respectively. The negative values of **(ĝi)** for this trait is required from breeding point of view since it refers to the short stature plant type. For chlorophyll content, highly significant and positive estimates of **(ĝi)** were recorded for Large stigma, indicating that this parent could be used to improve such trait.

Table (4): Estimates of general and specific combining ability effects of parents and their F1 crosses for all studied traits

Parents and crosses	Days to heading (day)	Plant height (cm)	Chlorophyll content (SPAD)	Number of panicles/plant	Panicle length (cm)	Number of Filled grains/panicle
GCA						
Giza 177	1.24**	2.63**	-0.60**	0.29	-1.02**	3.61**
Giza 178	3.52**	-2.42**	-1.57**	0.75**	-0.60**	-6.85**
Giza 179	0.23	-0.90**	0.27*	0.50	-0.20*	5.74**
SKC 23819-192	-0.36	5.40**	-0.07	0.54*	1.26**	-2.81**
Baldo	0.10	0.23	-0.17	-0.62**	0.91**	5.24**
Large stigma	-4.73**	-4.93**	2.13**	-1.46**	-0.36**	-4.93**
L.S.D. at 0.05%	0.58	0.25	0.26	0.51	0.14	1.13
at 0.01%	0.41	0.36	0.37	0.75	0.21	1.63
SCA						
Giza 177 x Giza 178	1.65**	-6.95**	-1.38**	0.10	-2.83**	-21.49**
Giza 177 X Giza 179	4.27**	-5.27**	-1.28**	0.02	-0.56*	-34.08**
Giza 177 X SKC 23819-192	-5.14**	5.97**	5.45**	1.64**	0.69**	28.46**
Giza 177 X Baldo	0.73	9.31**	2.62**	2.14**	1.23**	34.42**
Giza 177 X Large stigma	8.90**	10.47**	-3.05**	2.31**	1.47**	51.92**
Giza 178 X Giza 179	0.66	-0.86*	-2.01**	-0.77**	-0.22	-5.62**
Giza 178 X SKC 23819-192	-3.43**	-0.99**	-0.01*	1.18**	3.03**	-26.08**
Giza 178 X Baldo	-5.22**	-6.12**	-1.91**	0.68**	-2.29**	-9.79**
Giza 178 X Large stigma	4.95**	-0.06	-3.31**	0.18	0.08	10.38**
Giza 179 X SKC 23819-192	0.20	6.42**	-0.51*	-1.57**	-0.57*	-20.66**
Giza 179 X Baldo	4.41**	-1.33**	6.19**	-0.40*	-0.63**	20.30**
Giza 179 X Large stigma	0.57	5.46**	0.16*	1.77**	-0.79**	17.80**
SKC 23819-192 x Baldo	-0.01	12.53**	6.26**	2.56**	0.75**	7.84**
SKC 23819-192 x Large stigma	0.82*	-0.31	4.49**	1.39**	-0.91**	-28.66**
Baldo x Large stigma	-3.64**	-1.87**	5.59**	3.56**	0.47*	-12.37**
L.S.D. at 0.05%	0.78	0.68	0.70	0.29	0.40	3.12
at 0.01%	1.12	0.98	0.01	0.43	0.58	4.49

*, ** significant at 0.05 and 0.01 levels, respectively.

With respect to blast reaction the rice varieties; Giza 177, Giza 179 and Giza 178 exhibited significant and highly significant negative values of **(ĝi)**, while Large stigma and Baldo showed the positive values of **(ĝi)**. From the above mentioned results, it could be concluded that the rice variety Large stigma considered as good combiner for improving the number of days to heading (earliness), plant height and chlorophyll content. Obviously, estimates of **(ĝi)** showed that the parents, Giza 177, Giza 178 and Giza 179 were found to be good general combiners for blast reaction (Table 4).

Table (4): Continued

Parents and crosses	1000-grain weight (g)	Grain yield/plant (g)	Grain length (mm)	Grain width (mm)	Grain shape (mm)	Blast reaction
GCA						
Giza 177	-1.15**	-0.19	-0.38**	0.00	-0.13**	-0.32**
Giza 178	-3.82**	3.72**	-0.25**	-0.11**	-0.01	-0.19*
Giza 179	-1.30**	2.23**	-0.17**	-0.07**	0.06**	-0.28**
SKC 23819-192	2.02**	-2.65**	0.35**	0.10**	0.01	-0.15
Baldo	2.51**	0.45	0.24**	0.08**	0.00	0.43**
Large stigma	1.73**	-3.56**	0.22**	0.00	0.07**	0.51**
L.S.D. at 0.05% at 0.01%	0.14 0.20	0.58 0.83	0.04 0.06	0.03 0.05	0.03 0.04	0.19 0.27
SCA						
Giza 177 x Giza 178	2.17**	3.18**	0.47**	0.13*	0.09	0.01
Giza 177 X Giza 179	0.95**	-0.78	0.68**	0.26**	-0.05	0.09
Giza 177 X SKC 23819-192	0.72**	-2.66**	-0.43**	0.12*	-0.17**	0.30
Giza 177 X Baldo	-2.87**	13.12**	-0.63**	-0.19**	-0.06	-0.62*
Giza 177 X Large stigma	-2.75**	22.80**	-0.21**	0.16**	-0.13*	-0.70*
Giza 178 X Giza 179	3.42**	-4.69**	0.45**	0.34**	-0.16**	0.30
Giza 178 X SKC 23819-192	-2.43**	16.09**	-0.06	0.20**	-0.15**	0.84**
Giza 178 X Baldo	-1.56**	5.54**	-0.36**	-0.08	-0.04	-0.74*
Giza 178 X Large stigma	-0.28	13.22**	0.03	0.20**	-0.14**	-0.83**
Giza 179 X SKC 23819-192	-1.22**	-1.87*	-0.01	-0.01	-0.06	-0.08
Giza 179 X Baldo	-2.45**	12.58**	-0.48**	-0.01	-0.14**	-0.33
Giza 179 X Large stigma	-1.90**	2.59**	-0.52**	-0.04	-0.18**	-0.74*
SKC 23819-192 x Baldo	-0.47*	17.36**	-0.63**	-0.25**	0.00	-0.79**
SKC 23819-192 x Large stigma	-0.39*	-0.42	-0.47**	-0.17***	0.00	-0.54*
Baldo x Large stigma	1.92**	-4.21**	-0.27**	-0.01	-0.05	0.55*
L.S.D. at 0.05% at 0.01%	0.39 0.56	1.59 2.29	0.11 0.16	0.09 0.13	0.10 0.13	0.52 0.75

*, ** significant at 0.05 and 0.01 levels, respectively.

Moreover, Giza 178 and Giza 179 were the best general combiners for grain yield/plant. High **(ĝi)** of Giza 178 for grain yield was associated with its high **(ĝi)** for number of panicles/plant. While the high estimates of general combining ability of cultivar, Giza 179 for grain yield/plant was due to its highest estimates of number of panicles/plant and number of filled grains/panicle. The results also revealed that among the studied parents, Giza 177 followed by Giza 178 and Giza 179 were the best general combiners for short grain. Moreover, SKC 23819-192 and Baldo were the best general combiners for width grain. In addition, highly significant and positive estimates of general combining ability of grain shape were recorded for Giza 179 and Large stigma, indicating that these two parents were the greatest combiners for improving this trait. The results obtained are in agreement with that reported by **Hammoud (1996), EL-Abd *et al*. (2003), El-Mowafi (2003)** and **Kolom *et al*. (2014)**

Specific Combining Ability Effects (ĝij):

Estimates of specific combining ability effects are shown in Table (4). In case of days to heading, six crosses showed significant and highly significant positive estimates of **(ĝij)** ranged between 0.82 for SKC23819-192 x Large stigma and 8.90 for Giza 177 x Large stigma. While, four crosses gave highly significant and negative **(ĝij)** with values varied from -3.43 for Giza 178 x SKC23819-192 to –5.22 for Giza 178 x Baldo. The crosses which gave highly significant and negative estimates could be used as a donor to improve this trait. For plant height seven rice cross combinations showed significant and highly significant negative values of **(ĝij)**, indicating that these crosses may be useful in exploitation of heterosis due to their desirable plant stature.

Concerning chlorophyll content, Table (4), five crosses gave highly significant and positive of **(ĝij)**. The best crosses were (Giza 177 x SKC23819-192), (Giza 179 x Baldo), (SKC23819-192 x Baldo), (SKC23819-192 x Large stigma) and (Baldo x Large stigma) their estimated values were 5.45, 6.19, 6.26, 4.49 and 5.59, respectively. The combinations which showed significant and positive **(ĝij)** may be useful in exploitation of heterosis due to their desirable increase chlorophyll content. Blast reaction showed that **(ĝij)** of five crosses were high and highly significant negative ranging from -0.70 for (Giza 177 x Large stigma) to -0.83 for (Giza 178 x Large stigma). The crosses which gave negative significant values could be utilized in rice breeding program to improve this trait. The results obtained are in agreement with that reported by and **El-Malky and Elamawi (2013), Quaqua *et al.* (2015)** and **Owere *et al.* (2016)** also **Gangopadhyay and Mohanty (1983)** also reported the data on resistance to Pyricularia oryzae from a seven-parent diallel, including reciprocals, indicated that three specific cross combinations with good combining ability were identified. Additive genetic variance was more important than nonadditive.

As shown in Table (4), 5 crosses out of 15 combinations possessed significant desirable **(ĝij)** for grain yield / plant involving two kind of combinations between the parents of high and high **(ĝi)**, such as (SKC23819-192 x Baldo) recorded high x high parental **(ĝi)**, suggesting that additive x additive type gene action. **Manual and Palanisamy (1989)** also reported interaction between positive alleles in crosses involving high x high combiners which can be fixed in subsequent generations if no repulsion phase linkages are involved. Crosses like Giza 177 x Baldo, Giza 177 x Large stigma and Giza 178 x SKC23819-192 showed high x low or low x high parental **(ĝi)**, indicating the involvement of additive x dominance or dominance x additive genetic interaction. **Peng and Virmani (1990)** also reported about the possibility of interaction between positive alleles from good combiners and negative alleles from poor combiners in high x low crosses and suggested exploitation of heterosis in F1 generation. Their high yield potential would be unfixable in succeeding generations. Similar results were also obtained by **Dubey (1975)**. The cross Giza

178 x Large stigma recorded low x low parental **(ĝi)** indicating over dominance and epistatic interactions.

In the present study, the crosses (Giza 177 x Baldo) and (SKC23819-192 x Baldo) exhibited the highest **(ĝij)** for grain length. Similarly, (Giza 177 x Giza 179) and (Giza 178 x Giza 179) showed highest **(ĝij)** for grain width. The crosses which gave negative for grain length and positive for grain width could be utilized in rice breeding program to improve this trait. The result is in agreement with the work of **Hammoud (1996)** and **EL-Abd *et al*. (2003).**

From the foregoing results, the crosses Giza 177 x Baldo, Giza 177 x Large stigma, Giza 178 x Large stigma and SKC23819-192 x Baldo could be utilized in rice breeding program to improve yield and its components and blast resistance traits.

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تقديرات القدرة على التألف لبعض الصفات الخضرية والمحصولية والمقاومة لمرض اللفحة فى الارز

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تمت دراسة القدرة على التآلف لصفات وزن الحبوب والمقاومة لمرض اللفحة والصفات المحصولية فى الارز باستخدام نظام الهجن التبادلية بين ستة تراكيب وراثية مختلفة وذلك بدون الهجن العكسية وذلك بالمزرعة البحثية بمحطة بحوث سخا – سخا – كفرالشيخ – مصـــر وذلك أثناء موسمى 2015 و2016.

أوضحت النتائج أن النسبة بين كل من تباين القدرة العامة على التآلف الى تباين القدرة الخاصة على التآلف أقل من الواحد الصحيح ماعدا صفة وزن ال1000 حبة مشيرة إلى أهمية الفعل الجينى غير المضيف (السيادى و التفوقى) فى التحكم فى السلوك الوراثى لهذه الصفات. فضلا عن ذلك، اظهرت الصنف Large stigma قيم فائقة المعنوية وموجبة للقدرة العامة على التالف ولذا كان افضل الاباء لصفة محتوى الكلوروفيل، موضحة ان هذا الصنف يمكن الاعتمادعليه فى تحسن هذه الصفة فى برامج التربية . كما كانت الاصناف Giza 177، Giza 178 و Giza 179 افضل الاباء قدرة عامة على التالف حيث اعطت قيم عالية المعنوية وسالبة لصفة المقاومة لمرض اللفحة، بينما اظهر الصنفين Baldo و Large stigma قيم عالية المعنوية وموجبة للقدرة العامة على التالف لصفة المقاومة لمرض اللفحة. ومن جانب اخر، وجد ان الصنف Large stigma افضل الاباء قدرة عامة على التالف لصفات التبكير، قصرالنبات و محتوى الكلوروفيل وعليه يمكن

استخدامه فى برامج التربية لتحسن هذه الصفات.كما كانت الاصناف Giza 178 و Giza 179 افضل الاباء قدرة عامة على التالف لصفة محصول النبات الفردى.

اضافة الى ذلك فقد اظهرت خمسة هجن قدرة خاصة على التآلف عالية المعنوية وسالبة لصفة المقاومة لمرض اللفحة، ترواحت قيمها من -0.75 للهجين Giza 177x Large stigma الى -0.83 للهجين Giza 177x Large stigma لذلك يمكن اسخدامها فى برامج التربية لتحسين هذه الصفة. فضلا عن ذلك خمسة هجن من خمسة عشر هجينا اعطت قيم عالية المعنوية ومرغوبة للقدرة الخاصة على التالف لصفة محصول النبات الفردى، كما اظهرت النتائج ان الهجن ذات القدرة الخاصة الفائقة على التالف لصفة محصول الحبوب كانت نتيجة التهجين بين اباء ذات قدرة عامة عالية على التالف X اباء ذات قدرة عامة عالية على التالف كما فى الهجين SKC 23819-192 x Baldo، اباء ذات قدرة عامة عالية على التالف X اباء ذات قدرة عامة منخفضة على التالف كما فى الهجن Giza 177 x Baldo، Giza 177 x Large stigma و Giza 178 x SKC 23818-192 وكذلك اباء ذات قدرة عامة منخفضة على التالف X اباء ذات قدرة عامة منخفضة على التالف كما فى الهجين Giza 178 x Large stigma، موضحة ان التفاعل الجينى المضيف x المضيف ، المضيف x السيادى و السيادى x السيادى هى المتحكمة فى وراثة الصفات بهذه الهجن. توصى الدراسة بأن الهجين Giza 177 x Baldo، Giza 177 x Large stigma، Giza 178 x Large stigma و SKC23819-192 x Baldo يمكن استخدامها فى برامج تربية الأرز لتحسن صفات المحصول ومكوناته والمقاوة لمرض اللفحة.