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GENETIC BEHAVIOR OF MORPHOLOGY, YIELD, YIELD COMPONENTS AND GRAIN QUALITY IN RICE (*Oryza sativa* L.).

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ABSTRACT

The present investigation was carried out at the Farm of Sakha Agricultural Research Station, during 2012 and 2013 summer seasons. Combining ability analysis was estimated in rice through a 6 x 6 diallel set analysis involving 6 diverse parents for grain yield and its components and grain quality. Eight yield and its component and eight grain quality characters were studied. Mean square values of parents and crosses and parents vs crosses were found to be highly significant for all characters. 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 performance of the studied sixteen characters. GCA/SCA ratios were found to be greater than unity for all characters studied except for panicle length, number of filled grains/panicle and gelatinization temperature, indicating that the additive and additive x additive types of gene action were of great importance in the inheritance of all the studied characters except for the three mentioned traits which were controlled by non-additive genetic variance. The genotypes GZ 1368, Sakha106, Sakha 102 and Sakha 103 were good general combiners for most studied characters. Cross combinations involving such parents were superior for most of studied characters. The promising combinations for grain yield along with at least two of yield component characters were GZ1368 x Giza 177, Sakha 106 x Giza 176, Sakha 102 x Giza 177, Sakha 102 x Sakha 106, GZ 1368 x Sakha 103 and Giza 176 x Giza 177. Four crosses Sakha106 x Giza 177, Sakha103 x Giza177, Sakha102 x Giza 176 and Sakha103 x Giza176 showed highly significant and positive SCA for most studied grain quality characters. A greater magnitude of heterosis ranged between 2.38 and 13.88% was observed in seven crosses i.e. Sakha 103 x Sakha 106, Sakha 103 x Giza 176, Sakha 103 x Giza 177, GZ1368 x Giza 177, Sakha 106 x Giza 176, GZ1368 x Sakha 103 and Sakha 102 x Sakha 106 for grain yield /plant and grain quality characters. The availability of sufficient hybrid vigor in several crosses in respect of grain yield suggests that a hybrid breeding program could profitably be undertaken using these materials.

From the foregoing discussion, it may be concluded that the crosses, Sakha 103 x Sakha 106, Sakha 103 x Giza 176, Sakha 103 x Giza 177, GZ1368 x Giza 177, Sakha 106 X Giza 176, GZ1368 x Sakha 103 and Sakha 102 x Sakha 106 can be rated as the best crosses based on their heterosis in most of the studied traits including grain yield. Thus, it can be exploited in subsequent generations to improve most of the studied traits. Four crosses Sakha106 x Giza 177, Sakha 103 x Giza 177, Sakha 102 x Giza 176 and Sakha 103 x Giza 176 could be recommended for growing as hybrid rice.

INTRODUCTION

Rice is high impact on economy, lies within the fact that it occupies about 22% of the planted area in Egypt during the summer season. Moreover, rice is an important export crop. The amount exported was 500.000 tons RRTC (2002). The rice area increased during the last five years to about one and half million feddans. In Egypt, the success in releasing new rice varieties depend on rice breeding program will not only increase the rice production but also, maximize the farmer's income. Therefore, efforts are needed to develop improved rice cultivars with early maturity and higher grain yield potential. Rice as food in Egypt is challenged by increased demand on rice and threatened by declining water availability. Releasing rice crop cultivars that require less water without sacrificing productivity are needed. Grain quality characters of rice are the complex characters composed of many components such as nutritional quality and appearance. Cooking and eating quality to mention only a few. Each component also consists of many attributes that are determined not only by their physical – chemical properties but also by the history and cultural traditions of the human communities who consume the rice. Grain quality represented a major problem in rice production in Egypt. The main reason of this problem seems from the poor cooking and eating quality of many widely grown rice varieties, especially in Egypt (El-Hissewy and El-Kady, 1992). GCA (general combining ability) and SCA (specific combining ability) values help to identify good combiners and proper choice of male and female parent in hybrid rice programs and rice variety selection (Hammoud, 2004).

Therefore, the present investigation was aimed to Evolution the performance of some rice genotypes, Determine the mode of inheritance and type of gene action of yield and grain quality characters, Estimate phenotypic correlation among all possible yield and grain quality characters and Identify the most desirable genotypes as donors in future breeding programs.

MATERIALS AND METHOD

The present investigation was carried out at Sakha Agricultural Research Station, during 2012 and 2013 summer seasons. Six Egyptian rice cultivars, namely, GZ 1368, Sakha 102, Sakha 103, Sakha 106, Giza 176 and Giza 177 were crossed in half diallel design to estimate the general (GCA) and specific (SCA) combining ability and level of heterosis as compared to the better parent for grain yield, yield components and grain quality traits in rice. Parentage and type/ group of planted rice cultivars are given in Table 1

Six rice cultivars chosen based on their considerable level of variability in yield and its related characters were raised thrice at an interval of 10 days to overcome the differences in flowering time for the purpose of hybridization during 2012 summer season at Sakha Agricultural Research Station and a half diallel cross was carried out to produce 15 hybrids. Thirty days old seedlings from the fifteen cross combinations along with the six parents were transplanted in randomized complete block design with three replications during 2013 summer season at Sakha Farm Station. In each replication the size of the plot consisted of 5 rows, 5 m length and 20 cm apart. Spacing among plants was 20 x 20 cm. Each hybrid was raised in 5m length plot size. The three central rows were used for data collection and observation. Other cultural practices were used as recommended. Twenty plants were randomly taken from each parent and each F_1 cross, from each replicate. Data were collected on eight rice characters, morphology, yield and its components viz; plant height (cm), days to complete heading, panicle length (cm), number of panicles / plant, number of filled grains / panicle, sterility%, 100-grain weight and grain yield /plant (g). Also, eight grain quality characters viz; grain shape%, hulling %, milling%, head rice%, grain elongation%, gel consistence, gelatinization temperature and amylose content% were studied.

Table (1): Parentage and type of planting group of rice cultivars

No	Genotype	Parentage	Type
1	GZ1368	Egyptian saline tolerant line	*Japonica/Indica*
2	Sakha 102	GZ4089-7-1 x Giza 177	*Japonica*
3	Sakha 103	Giza 177 x Suweon 349	*Japonica*
4	Sakha 106	Giza 177 x Hexi 30	*Japonica*
5	Giza 176	Calrose 76 x Giza 172 x G242	*Japonica*
6	Giza 177	Giza 171 x Yomji no 1 x pi no4	*Japonica*

The studied traits were recorded as follows:

a- Yield and its component

1- **Plant height (cm):** Length of the main culm measured from the soil surface to the tip of the main panicle at maturity.
2- **Days to heading (days):** were determined as the number of days from date of sowing to the date of the first panicle exertion.
3- **Panicle length (cm):** Length of main panicle was measured from the base to the tip of panicle at complete maturity.
4- **Number of panicles / plant**: was determined by counting the number of panicles / plant, when the plant reached ripening stage.
5- **Number of filled grains / panicle:** Average number of grains formed on randomly chosen five main culms carrying panicle.
6**- Sterility %:** Average number of unfilled grains relative to filled grains / panicle
7- **100-grain weight (g)**: was recorded as the weight of 100 random filled grains.
8- **Grain yield/plant (g)** was recorded as the weight of grain yield of each individual plant.

b- Grain Quality Characters.

1-Grain shape: was determined by the length (L): Width (W) ratio**.**

2-Hulling %: Brown rice weight (g) / Total rough rice weight (g) x 100.

3- Milling %: Total milled rice weight (g) / Total rough rice weight (g) x 100.
4-Head rice % = Weight of head rice (g) / Milled rice weight (g) x 100.
5-Grain elongation % = Grain length after cooking (mm) / Grain length before cooking mm) x 100**.**
6-Gelatinization temperature: determined as was recorded by Little *et al.* (1958).
7-Gel consistency: was determined as carried out by Cagampang *et al* (1973).
8- Amylose content: was determined according of Williams *et al*.(1958).

Statistical analysis:

The combining ability analysis was done following (Griffings, 1956) Model 1 Method 2. The data for each measurement were tabulated and analyzed by Fisher's analysis of variance (Steel and Torrie, 1980). The diallel analysis was used to evaluate traits that show significant variation among the parents. Significant differences in phenotypes assumed to imply that genetic differences were present. Simple additive – dominance model approach of Hayman (1954) and Singh and Chaudhary (1979) as modified by Mather and Jinks (1982) was followed for genetic analysis and for the estimation of components of genetic variation. The significance of components of variation in F_1 generation was tested by Mather and Jink (1971).

Estimation of heterosis:

Useful heterosis for each trait of individual crosses was calculated as the percentage increase in F_1 performance above the better parent performance. Heterosis over better-parent % was estimated as follows:

$$\text{H (\%)} = \frac{F_1\text{-BP X 100}}{\text{BP}}$$

Where, F_1 = Mean value of the first generation and BP= Mean value of the better-parent. Appropriate LSD value was calculated to test the significance of the heterotic effects, according to the following formula, suggested by Wynne *et al.* (1970).

LSD for better parent heterosis = t $(\sqrt{2MSe/r})$

Where: t = tabulated "t" value at the specified level of probability for the experimental error degrees of freedom. MSE = the experimental error mean squares of the analysis of variance, and r = number of replications.

RESULTS AND DISCUSSION

a. Analysis of variance

Analyses of variance for the studied traits under investigation are presented in Tables 2 and 3. The genotype mean squares were highly significant for all the studied traits indicating wide range of genetic variability among the studied genotypes and this is a primary requirement for further computation**.** Mean square values of parents and crosses were found to be highly significant for all characters. Parents Vs crosses mean squares were highly significant for all yield and its component and grain quality characters. Both general and specific combining ability variance were found to be highly significant for all characters, indicating the importance of both additive and non-additive genetic variance in determining the performance of these sixteen characters. General combining ability/specific combining ability ratio was used to clarify the nature of the genetic variance involved. With the exception of three traits under investigation; panicle length, number of filled grains/panicle, and grain elongation; GCA/SCA ratios were found to be less than unity indicating non-additive inheritance for these three characters. For all remaining characters under study GCA/SCA ratios were exceeding unity indicating that the additive and additive x additive types of gene action were of great importance in the inheritance of all the studied characters except for these three mentioned traits which were controlled by non-additive genetic variance. Therefore, it could be concluded that the presence of large amounts of additive effects suggests the potentiality for obtaining further improvement in the studied characters. Also, selection procedure based on the accumulation of additive effects. would be very successful in improving these characters. However, to maximize selection advance, procedures which are known to be effective in shifting gene frequency, when both additive and non-additive genetic variation are present should be involved.

The obtained results agreed with those previously observed by El-Abd (2003), Abd El-Lattef (2004), Hammoud (2004), Sinha *et al.* (2006), Mujataba *et al.* (2007) and Rahimi1 *et al.* (2010).

Table (2):Mean square estimates of ordinary and combining ability analysis for yield and yield component characters.

S.O.V.	d.f	Days to complete heading (days)	Plant height (cm)	Panicle length (cm)	No. of panicles /plant	No. of filled grains /panicle	Sterility %	100-grain weight(g)	Grain yield/plant
Replications	**3**	12.26	8.14	1.22	1.36	65.41	2.67	0.82	24.82
Genotypes	**20**	198.27**	300.24**	29.17**	14.35**	1624.18**	11.63**	15.24**	369.14**
Parents (P)	**5**	2134.25**	224.38**	5.27**	62.38**	8245.64**	416.34**	19.22**	589.65**
Crosses (Cr)	**14**	201.47**	212.82**	19.25**	8.26**	156.37**	8.63**	21.74**	177.35**
P. vs Cr.	**1**	175.41**	299.64**	87.41**	39.26**	3915.71**	89.75**	20.48**	2684.45**
Error	**60**	11.72	6.24	1.13	1.08	63.54	1.94	2.17	15.64
G.C.A	**5**	140.81**	197.45**	4.12**	8.69**	132.45**	9.46**	4.27**	201.34**
S.C.A	**15**	35.86**	29.84**	4.63**	3.54**	395.73**	4.61**	6.27**	59.42**
Error	**60**	2.97	1.09	0.63	0.48	14.62	0.54	0.73	5.42
GCA / SCA		4.98	6.18	0.96	5.46	0.68	3.95	1.47	4.87

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

Table (3): Mean square estimates of ordinary and combining ability analysis for some grain quality characters.

S.O.V.	d.f	Grain Shape%	Hulling %	Milling %	Head Rice %	Grain Elongation %	Gel Consistence	Gelatinization Temperature	Amylose content %
Replications	3	0.73	11.45	9.42	7.34	0.35	10.89	0.94	1.64
Genotypes	20	16.84**	201.45**	195.64**	163.24**	7.49**	199.74**	19.46**	16.78**
Parents (P)	5	17.62**	235.14**	231.42**	214.36**	9.41**	249.71**	21.84**	74.62**
Crosses(Cr)	14	20.36**	297.12**	214.63**	199.48**	10.43**	250.34**	26.25**	9.74**
P. vs Cr.	1	19.48**	264.53**	199.47**	145.63**	9.36**	238.74**	21.89**	42.68**
Error	60	1.97	5.28	4.63	3.25	1.23	4.97	2.94	1.64
G.C.A	5	3.94**	154.81**	114.56**	104.67**	2.15**	123.49**	4.89**	9.47**
S.C.A	15	5.42**	25.29**	22.64**	19.75**	3.21**	422.19**	5.79**	4.93**
Error	60	0.55	1.23	1.15	0.97	0.32	1.12	0.84	0.63
GCA / SCA		1.64	5.46	2.41	1.99	0.54	4.73	1.97	6.41

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

b.Mean performance of parents and their F_1 generation:

The performance of parents and F_1 generation are presented in Table 4. It shows that the tallest plants were observed in GZ 1368 followed by Sakha 102, Giza 176, Sakha 106 and Sakha 103, while, the earlier and shortest ones were exhibited in Sakha 103 and Sakha 106, followed by Sakha 103, Sakha 106, Sakha 102 and Giza 176. On the contrary, GZ 1386 was the latest one in days to complete heading. In addition, Sakha 106 had the longest panicle (23.15cm), followed by Giza 177, Sakha 103, Sakha 102 and Giza 176, but GZ 1368 gave the shortest panicle length (18.99 cm). Whereras, Giza 176, Sakha 103, Giza 177 and Sakha 102 gave the highest number of panicles/ plant, GZ 1368 gave lowest (13.98 cm) number of panicles per plant. On the other hand, high number of filled grains /panicle (146.58 fertile grains) was recorded for Sakha 106 followed by GZ 1368 (140.25), Sakha 103 (132.65) and Giza 176 (128.99), while the lowest number of field grains/panicle (119.23) was recorded for Giza 177. Lowest sterility% was recorded for Sakha 106 (12.36%) followed by Giza 176 (13.71%) but, the highest sterility% was recorded for Sakha 103 (19.74%). Heaviest 100-grain (2.73 g) weight was recorded from Sakha 106, followed by Sakha 102 (2.63 g) and GZ1368 (2.62 g). Highest grain yield/plant (42.68 g) was obtained from Sakha 106 followed by Sakha103 (39.18 g), Sakha 102 (36.45 g/), Giza 177 (35.26 g) Giza 176 (32.65 g), while GZ 1368 rice variety gave the lowest rice grain yield/plant.

The F_1 mean values of all rice crosses were earlier than the late rice cultivar; GZ 1368 from almost 1 to 17 days. Seven rice crosses, Sakha 102 x Sakha 106, Sakha 102 x Giza 176, Sakha 106 x Giza 177 (90 days), Sakha 102 x Giza 177, Sakha 102 x Sakha 103, Giza 176 x Giza 177 (91 days) and Sakha 103 x Giza 177 (92 days) were earlier than the earliest rice cultivar, Giza 177 (93 days). Moreover, plant height ranged between 94.53cm for (Sakha 103 x Giza 177) and 107.25 cm for (GZ1368 X Sakha102) rice cross, which agree with the target of rice breeders for selection of short stature rice genotypes, resistance to lodging and suitable for mechanical harvesting. The highest estimated values of panicle length and number of field grains / panicle were recorded from cross Sakha 102 x Sakha 106. Also, highest estimated values of number of panicles /plant were recorded on Sakha 106 x Giza 176 rice cross. Moreover, lowest sterility % and highest grain yield / plant were detected for Sakha 106 x Giza 176 (12.28 % and 44.35 g / plant) followed by GZ1368 x Sakha106 (13.71 % and 43.62 g / plant) in that order. While the heaviest 100 grain weight was recorded from Sakha 102 x Giza 177 rice cross. Maximum grain yield /plant was observed for Sakha 106 x Giza 176 (44.35), while the minimum grain yield / plant (29.02 g) was harvested from Sakha 102 x Sakha 176 cross, making almost a range between 4.620 and 3.465 ton/feddan, respectively, indicating possibility of increasing grain yield through hybridization followed by selection in any traditional breeding program.

The rice grain quality characters are presented in table (5). The highest mean values of grain shape for the parents were (2.62 %) obtained from

Sakha 106, followed by Sakha 102 (2.45 %) and GZ1368 (2.41 % cm). While the highest hulling %, milling % (82.14 % and 73.25 % respectively) was recorded from GZ1368 rice variety. Highest head rice % (68.17 %) was obtained from Sakha 10, followed by Giza 177 (67.41 %). On the other hand, longest grain elongation (0.80 %) was recorded for Sakha 103. Also highest gel consistence (95.23%) and low amylose content (18.27 %) were obtained for Sakha 106. Also, the intermediate of gelatinization temperature was recorded from GZ1368 rice variety.

The F_1 mean values of grain quality characters (Table 5) showed that the bold grain shape (2.75 %) was obtained for Sakha 102 X Sakha 106, followed by (2.73) for Sakha 106 X Giza 176, (2.68 %) for GZ1368 X Sakha 103 and (2.54 %) for Sakha 106 X Giza 177. The highest hulling %, milling % and head rice % were recorded from GZ1368 X Sakha 106. Highest mean of grain elongation (0.82 %) was recorded for Sakha 103 X Sakha 106, followed by (0.79 %), Sakha 103 X Giza 176. Highest mean values for gel consistence (94.67) obtained for Sakha 102 X Sakha 106, followed by (94.58) for Sakha 103 X Sakha106.

Also, intermediate gelatinization temperature % (5.94%) recorded from GZ1368 X Sakha102, while the other remaining crosses had low gelatinization temperature. On the other hand cross Sakha 103 X Sakha 106 was the lowest one for amylose content.

Table (4): Mean performance of the six parents and their F_1 generation of 6 x 6 diallel cross for some yield and its component characters.

genotypes	Days to complete heading	Plant height (cm)	Panicle length (cm)	No. of panicles /plant	No. of filled grains /panicle	Sterility %	100-grain weight (g)	Grain yield /plant (g)
GZ 1368	107	105.22	18.99	13.98	140.25	15.22	2.62	30.25
Sakha 102	102	102.31	20.12	19.24	125.31	14.63	2.63	36.45
Sakha 103	100	95.14	21.48	20.15	132.65	19.74	2.54	39.18
Sakha 106	100	100.25	23.15	22.54	146.58	12.36	2.73	42.68
Giza 176	105	102.15	20.18	15.24	128.99	13.71	2.61	32.65
Giza 177	103	90.24	22.59	19.34	119.23	16.84	2.48	35.26
GZ1368 X Sakha 102	105	107.25	20.12	16.51	132.56	15.83	2.63	36.14
GZ1368 X Sakha 103	102	102.28	22.15	18.62	139.54	16.23	2.57	38.25
GZ1368 X Sakha 106	100	103.51	21.98	21.14	156.24	13.71	2.68	43.62
GZ1368 X Giza 176	107	105.41	20.17	14.36	139.25	14.82	2.44	31.17
GZ1368 X Giza 177	103	99.15	21.59	15.72	137.62	15.63	2.52	33.02
Sakha 102 X Sakha 103	91	98.81	21.45	20.21	125.34	16.84	2.51	35.26
Sakha 102 X Sakha 106	90	101.08	24.78	21.45	159.12	13.81	2.66	41.19
Sakha 102 X Giza 176	90	104.95	21.47	18.27	130.36	14.62	2.52	29.15
Sakha 102 X Giza 177	91	97.58	22.35	19.36	124.13	15.73	2.78	31.45
Sakha 103 X Sakha 106	101	97.26	22.51	23.15	147.56	18.87	2.63	41.91
Sakha 103 X Giza 176	103	100.15	20.45	18.54	131.56	16.23	2.59	34.18
Sakha 103 X Giza 177	92	94.53	21.52	21.59	125.46	20.74	2.45	35.26
Sakha 106 X Giza 176	104	101.48	22.47	24.82	139.52	12.85	2.53	44.35
Sakha 106 X Giza 177	90	96.43	24.37	23.14	132.71	15.62	2.59	37.54
Giza 176 X Giza 177	91	95.24	22.42	17.52	126.45	14.53	2.52	33.28
LSD at 0.05	2.28	3.15	1.98	3.74	4.13	1.12	0..27	2.56
LSD at 0.01	3.48	4.62	2.67	4.58	5.26	1.95	0.86	3.79

Table (5): Mean performance of the six parents and their F_1 generation of 6 x 6 diallel cross for some grain quality characters.

genotypes	Grain Shape %	Hulling %	Milling %	Head Rice %	Grain Elongation %	Gel Consistence	Gelatinization Temperature	Amyls content %
GZ 1368	2.41	82.14	73.25	66.23	0.67	87.15	5.24	29.17
Sakha 102	2.45	80.54	68.15	60.45	0.71	89.23	6.26	19.25
Sakha 103	2.36	79.16	71.28	64.28	0.80	93.54	6.52	18.27
Sakha 106	2.62	81.24	72.56	68.17	0.76	95.23	6.63	19.56
Giza 176	2.15	80.25	72.54	65.82	0.63	94.28	6.28	20.34
Giza 177	2.23	70.41	73.15	67.41	0.67	78.36	6.11	21.59
GZ1368 X Sakha 102	2.41	81.14	72.20	65.24	0.68	88.34	5.94	25.16
GZ1368 X Sakha 103	2.43	80.23	73.26	64.35	0.78	89.64	6.28	20.15
GZ1368 X Sakha 106	2.68	83.15	74.85	70.58	0.72	92.45	6.41	23.45
GZ1368 X Giza 176	2.34	81.20	71.25	65.48	0.64	91.42	6.12	22.34
GZ1368 X Giza 177	2.41	75.46	73.65	66.28	0.67	80.26	6.15	26.15
Sakha 102 X Sakha 103	2.42	80.31	70.24	63.24	0.75	91.28	6.35	16.25
Sakha 102 X Sakha 106	2.75	82.54	73.62	69.13	0.74	94.67	6.42	19.87
Sakha 102 X Giza 176	2.29	80.63	71.15	64.18	0.72	93.45	6.19	20.18
Sakha 102 X Giza 177	2.28	76.21	70.52	64.32	0.70	88.72	6.05	20.36
Sakha 103 X Sakha 106	2.51	80.24	72.15	65.22	0.82	94.58	6.74	18.46
Sakha 103 X Giza 176	2.23	80.34	71.13	65.27	0.79	93.26	6.38	19.58
Sakha 103 X Giza 177	2.41	75.16	72.58	66.38	0.69	82.45	6.27	19.45
Sakha 106 X Giza 176	2.73	82.19	73.65	69.48	0.68	94.35	6.41	19.24
Sakha 106 X Giza 177	2.54	80.24	71.64	68.32	0.72	90.28	6.35	20.24
Giza 176 X Giza 177	2.26	76.25	72.58	66.45	0.65	92.46	6.18	20.59
LSD at 0.05	0.21	2.13	1.29	197	0.11	2.24	0..23	2.14
LSD at 0.01	0.54	3.24	2.15	2.34	0.21	3.79	0.76	3.26

c. Estimates of general (GCA) and specific (SCA) combining ability:

Obviously, estimate of GCA showed that the parents GZ1368, Sakha 106 and Sakha 103 were found to be good general combiners for grain yield/plant (Table 6). High GCA effect of GZ1368 was associated with its high GCA effect for panicle length, number of panicles /plant, number of filled grains /panicle, lowest sterility% and 100 grain weight. The good combining ability of cultivar Sakha 106 was due to high elongation of its panicle and its heavy grains, while the high estimates of general combining ability of cultivar Sakha 103 for grain yield /plant was due to its highest estimates of panicle length and number of panicles /plant. The results also revealed that among the studied parents, GZ1368, followed by Sakha 106 and Sakha 103 were the best general combiners for tall plant height. Moreover, Giza 177, Sakha 103, GZ1368 and Giza 176 were the best general combiners for earliness.

General combining ability (GCA) estimates for grain quality characters (Table 7) showed that, the best GCA were recorded for Sakha 102, Giza 177 and GZ1368 for grain shape. While good GCA for hulling % was recorded for GZ1368, Sakha103, Giza 176. On the other hand best GCA for milling and head rice were obtained for Sakha 106, Sakha 103 and Sakha 102.

Moreover, best GCA for grain elongation was recorded for Sakha 103, GZ1368 and Sakha 102. While best GCA for gel consistence was recorded for Sakha 106, GZ1368 and Sakha 103. Best GCA of gelatinization temperature was obtained for Sakha 102, Sakha 106. Also best GCA for amylose content was obtained for Sakha 106, Sakha 102, Giza 176 and Giza 177. Therefore, it may be concluded that identifying crosses involving these parents would result in possibility of superior genotypes with favorable genes for grain yield and component characters and other grain quality characters. High GCA effects are related to additive and additive X additive components of genetic variation, the parents with higher positive significant GCA effects are considered as good combiners, while those with Negative GCA effects are poor general combiners except for in case of plant height, earliness and sterility%. Similar results were obviously recorded by El-Abd (2003), Hammoud (2004), Shehata (2004), Satish and Seetharamaiah (2005), Sharma *et al.* (2005), Dhakar and vinit (2006), El-Abd *et al.* (2007) and Saleem *et al.* (2008).

Table (6): Estimates of general combining ability (GCA) effects for yield and its component characters.

Parents	Days to complete heading	Plant height (cm)	Panicle length (cm)	No of panicles /plant	No. of filled grains /panicle	Sterility %	100-grain weight (g)	Grain yield /plant (g)
GZ 1368	-3.56**	4.63**	0.25**	0.38**	6.44**	2.63**	0.63**	5.46**
Sakha 102	2.57**	-5.23**	-0.84 **	-1.23**	-5.36**	2.74*	-1.94**	-4.62**
Sakha 103	-3.61**	4.12**	0.52**	-0.89**	-2.41**	-2.63**	1.28*	3.86**
Sakha 106	3.54**	-4.15**	1.42**	1.46**	11.71**	-2.94**	-1.36**	4.36**
Giza 176	-2.63**	4.29**	-0.73**	-1.67**	-3.45**	-1.02**	0.49	-3.52**
Giza 177	-3.72**	-3.27**	0.41**	-0.83**	-7.41**	1.11**	0.79**	-4.86**
S.E. at 0.05	0.54	0.63	0.25	0.17	1.22	0.54	0.11	0.93
S.E. at 0.01	1.63	1.54	0.36	0.21	2.16	0.93	0.26	1.15

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

Table (7): Estimates of general combining ability (GCA) effects for some grain quality characters.

Parents	Grain Shape%	Hulling %	Milling %	Head Rice %	Grain Elongation %	Gel Consistence	Gelatinization Temperature	Amyls content %
GZ 1368	-0.54**	5.12**	-4.26**	3.41**	0.29**	4.18**	1.44**	1.54**
Sakha 102	1.82**	-5.82**	-4.82 **	2.64**	0.25**	-5.12**	-3.93**	-1.64**
Sakha 103	-1.63**	5.01**	4.96**	3.52-**	0.36**	4.17**	2.84*	-1.05**
Sakha 106	-1.95**	-6.28**	5.41**	3.63**	-0.48**	5.94**	-3.04**	1.84**
Giza 176	-0.33**	4.96**	-3.71**	-4.01**	-0.15**	-3.82**	1.28	-1.52**
Giza 177	0.84**	-4.21**	3.12**	2.87**	-0.26**	-3.97**	1.84**	1.01**
S.E. at 0.05	0.21	0.84	0.15	0.82	0.12	0.43	0.16	0.73
S.E. at 0.01	0.32	1.63	0.42	1.04	0.26	0.96	0.38	1.25

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

The estimates of specific combining ability of 15 crosses for 8 yield and its components are presented in Tables 7. It is observed that a total of 6 crosses GZ1368 x Giza 177, Sakha 106 x Giza 176, Sakha 102 x Giza 177, Sakha 102 x Sakha 106, GZ 1368 x Sakha 103 and Giza 176 x Giza 177 exhibited positive and significant SCA for grain yield /plant. These crosses are promising combinations for grain yield along with at least two of yield components. It is observed that majority of the crosses with high SCA for grain yield were involved with low / high or high / low or high / high or low / low combining parents. But very few crosses showing low / low general combiners showed high SCA .The cross combinations showing high negative SCA for days to heading were GZ 1368 x Giza 176, Sakha 103 x

Sakha 106, GZ1368 x Sakha 102, Sakha 102 x Sakha 106, Sakha 106 Giza 177 and Sakha 106 x Giza 176. On the other hand The cross combinations showing high negative SCA for plant height were Sakha 106 x Giza176, Sakha 103 x Sakha 106, Sakha 102 x Giza 177, Sakha 102 x Sakha 106, Sakha 103 x Sakha 103 and GZ1368 x Giza 177. For panicle length and number of panicles / plant positive estimates of SCA are desirable and the good specific combinations were GZ1368 x Sakha 103, Sakha 102 x Giza 177, Sakha 102 x Sakha 106, GZ1368 x Giza 177 and Sakha 102 x Sakha 103. The cross combinations viz., Sakha 102 X Giza 177, GZ1368 x Sakha 103, Sakha 106 x Giza176, Sakha 102 x Sakha 106, Sakha 106 x Giza 177 and GZ1368 x Sakha 103, were good specific combinations for number of filled grains / panicle. The best specific combinations for sterility % were Sakha 102 x Giza 177, GZ 1368 x Sakha 103 and Sakha 102 x Sakha 106.

Table (8): Estimates of specific combining ability (SCA) effects for yield and its component characters.

Crosses	Days to complete heading	Plant height (cm)	Panicle length (cm)	No. of panicles /plant	No. of filled grains /panicle	Sterility %	100-grain weight (g)	Grain yield /plant (g)
GZ1368 X Sakha 102	-6.21**	4.27**	-3.95**	-1.74**	5.84	2.97**	-2.94**	-5.93**
GZ1368 X Sakha 103	2.56	-4.99**	4.25**	1.63**	12.73**	-4.91**	2.63**	5.97**
GZ1368 X Sakha 106	8.49**	-3.12**	-3.28**	-1.52**	-16.45**	3.02**	-1.91**	-5.26**
GZ1368 X Giza 176	-6.48**	-4.25**	-0.69*	1.94**	-32.74**	1.46*	-3.54**	-8.42**
GZ1368 X Giza 177	3.15**	-3.99**	2.24**	1.63**	20.62**	-2.87**	1.82**	8.97**
Sakha 102 X Sakha 103	6.49**	-4.28**	2.06**	-2.41**	-14.81**	1.54**	-2.13**	-5.24**
Sakha 102 X Sakha 106	-5.22**	-5.98**	4.21**	0.68	18.27**	-3.62**	3.25**	6.05**
Sakha 102 X Giza 176	1.97	-4.23**	-2.35**	-1.96**	-8.42**	3.41**	-4.08**	1.35
Sakha 102 X Giza 177	5.24**	-4.29**	4.23**	1.84**	31.64**	-4.94**	4.12**	7.62**
Sakha 103 X Sakha 106	-6.24**	-6.27**	-3.74**	-2.08**	-13.52**	3.34**	-0.84	-9.41**
Sakha 103 X Giza 176	2.81**	-4.35**	0.94	2.94**	5.47	-2.22**	4.92**	5.42**
Sakha 103 X Giza 177	1.42	-5.48**	-2.85**	-1.04**	-6.23*	2.97**	-3.05**	-4.28**
Sakha 106 X Giza 176	-0.95	-7.42**	3.69**	1.82**	19.62**	-2.04**	2.74**	8.19**
Sakha 106 X Giza 177	-3.27**	6.95**	-2.14	2.31**	15.46**	-1.08	-2.25**	-9.41**
Giza 176 X Giza 177	8.41**	2.22*	1.02**	1.64**	13.27**	-1.21*	2.14**	5.69**
S. E. at 0.05	1.63	1.47	0.83	0.59	3.27	0.74	0.84	2.15
S.E. at 0.01	2.45	2.04	1.42	0.86	5.14	1.22	1.27	3.24

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

Four crosses namely, Sakha 103 x Giza 176, Sakha 102 x Giza 177, Sakha 102 x Sakha106 and Sakha 106 x Giza176 exhibited highly significant and positive SCA effects for100-grain weight. SCA for grain quality characters presented in Table 9, shows that eight crosses; Sakha103 x Giza 176, Sakha102 x Giza176, Sakha102 x Giza 177, Sakha103 x Giza 177, Giza176 x Giza 177, Sakha102 x Sakha 103, GZ1368 x Sakha 106 and Gz1368 x Sakha 103 were highly significant and positive for grain shape. While seven crosses Sakha 106 x Giza 177, GZ1368 x Sakha 103, Sakha 103 X Giza 177, Sakha 102 x Giza 177, GZ1368 x Giza 177, GZ1368 x Sakha 106 and Giza 176 X Giza 177 had highly significant and positive SCA for hulling, milling and head rice %. Also 5 crosses, Sakha103 x Sakha 106, GZ1368 x Giza176, Giza 176 x Giza 177, Sakha106 x Giza 177 and GZ1368 x Sakha 102 showed highly significant and positive SCA for grain elongation.

The best positive SCA for gel consistence was recorded for Sakha 102 x Sakha 106, GZ1368 x Giza 176, GZ1368 x Giza 177, Sakha 106 x Giza 177 and GZ1368 x Sakha 102. On the other hand, 5 cross Sakha 102 x Giza 176, GZ1368 x Giza 176, Sakha 106 x Giza 176 and GZ1368 x Giza 177 showed highly significant and negative SCA for gelatinization temperature. Also negative highly significant SCA for amylose content was obtained from Sakha 106 x Giza 177, Sakha 102 x Giza 177, Sakha 103 x Giza 177 and Gz 1368 x Giza 103.

Moreover, these cross combinations also included the parents recorded either good or poor GCA for these traits. Through there is a preponderance of non-additive gene action for grain yield and its components and grain quality characters in the hybrids resulted in high amount of vigor in F_1, where selection can be postponed to later generation. These findings were in agreement with those of Yu *et al.* (2004), Bagheri *et al.* (2005), Rosamma and Vijayakumar (2005), Paradhan *et al.* (2006)., Radish *et al.* (2007), Abd –El-Lattef and Badr (2007), El-Abd *et al.* (2007), Saleem *et al.* (2008) and Rahimi1 *et al.* (2010).

Table (9): Estimates of specific combining ability (SCA) effects for grain quality characters.

Crosses	Grain Shape%	Hulling %	Milling %	Head Rice %	Grain Elongation %	Gel Consistence	Gelatinization Temperature	Amyls content %
GZ1368 X Sakha 102	-2.63**	-4.88**	-2.68**	-1.97**	1.02	-4.62**	3.67**	3.91**
GZ1368 X Sakha 103	2.15	5.12**	3.51**	2.63**	-1.69**	-3.74**	2.84**	-4.67**
GZ1368 X Sakha 106	1.23**	3.69**	-3.94**	2.41**	-1.42**	3.56**	-2.86**	4.16**
GZ1368 X Giza 176	-2.46**	-3.97**	-0.76*	2.63**	2.74**	-2.46*	-4.22**	6.32**
GZ1368 X Giza 177	1.42**	4.01**	3.48**	1.99**	-0.61**	3.46**	2.84**	4.21**
Sakha 102 X Sakha 103	2.25**	-4.39**	2.56**	-2.11**	-1.41**	2.84**	3.62**	3.14**
Sakha 102 X Sakha 106	-3.12**	-6.27**	4.55**	1.32	-1.27**	-4.53**	4.67**	4.22**
Sakha 102 X Giza 176	3.56	-3.64**	-3.15**	-2.05**	-2.22**	3.94**	4.98**	-2.63
Sakha 102 X Giza 177	3.22**	4.28**	4.96**	2.95**	-1.62**	-5.14**	4.58**	-5.41**
Sakha 103 X Sakha 106	-1.54**	-5.41**	-4.28**	-2.28**	-1.72**	-3.96**	1.28	6.28**
Sakha 103 X Giza 176	3.62**	-4.68**	-1.08	-3.74**	3.41	2.74**	5.39**	5.26**
Sakha 103 X Giza 177	2.96	4.97**	3.97**	2.68**	-2.13*	-3.29**	3.96**	-3.99**
Sakha 106 X Giza 176	-1.95	-6.28**	-3.98**	-2.13**	-1.42**	-2..94**	-2.89**	7.29**
Sakha 106 X Giza 177	-2.36**	5.41**	2.63	2.64**	1.16**	-2.13	-2.64**	-8.11**
Giza 176 X Giza 177	2.64**	2.97*	2.63**	1.53**	1.23**	1.26*	2.39**	4.39**
S. E. at 0.05	0.63	1.03	0.94	0.94	0.27	0.84	0.93	1.22
S.E. at 0.01	1.13	2.62	1.63	1.22	0.54	1.64	1.66	2.14

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

d.Estimates of better parent heterosis:

Large number of crosses exhibited high estimates of heterosis in a desirable direction for different characters under study. The estimates of heterosis for yield and its component characters are presented in Table 10. A greater magnitude of heterosis ranged between (2.38 and 13.88%) was observed in seven crosses Sakha 103 x Sakha 106, Sakha 103 x Giza 176, Sakha 103 x Giza 177, GZ1368 x Giza 177, Sakha 106 X Giza 176, GZ1368 x Sakha 103 and Sakha 102 x Sakha 106 for grain yield /plant. The availability of sufficient hybrid vigor in several crosses in respect of grain yield suggests that a hybrid breeding program could profitably be undertaken in rice. For days to complete heading the crosses Sakha102 X Giza 176, GZ1368 x Sakha 102, Sakha 102 x Giza 177, Sakha 102 x Sakha 106, Sakha 106 x Giza 176 and Sakha 103 x Giza 176 exhibited high negative heterosis, Appearance of significant and negative heterosis for days to complete heading indicated the possibility of exploiting heterosis for earliness. Also plant height, six crosses, GZ 1368 x Giza 177, Sakha102 x Giza 177, GZ1368 x Sakha 103, Sakha 106 x Giza 177, Sakha 103 x Sakha 106 and Sakha 106 x Giza 176 recorded significant heterosis in a desirable negative direction. Six crosses, Sakha106 x Giza177, Sakha 102 x Giza176, GZ1368 x Sakha 103, Sakha 103 x Giza 177, Sakha 106 x Giza 176 and Sakha 102 x Sakha 106 recorded significant heterosis in a desirable positive direction for panicle length. While, highly significant and positive estimates of heterosis were observed for number of panicles /plant in six the crosses namely GZ1368 x Giza 177, GZ1368 x Sakha 103, Sakha 106 x Giza 176, Sakha 103 x Giza 177, Sakha 102 x Sakha 106 and Sakha 106 x Giza 177. On the other hand, desirable heterosis was found among two studied crosses Sakha 102 x Sakha 106 (8.90 %) and GZ1368 x Sakha 106 (6.84 %) for number of filled grains/panicle.

Out of fifteen studied crosses, only three crosses, Sakha 106 x Giza 177, Sakha 102 x Sakha 106 and Sakha 102 x Giza 177 exhibited highly significant negative estimates of heterosis for sterility %. The estimates of desirable heterosis, for 100 grain weight were recorded in two crosses Sakha 103 x Giza 177 and Sakha 102 x Giza 177 only.

Table (10): Estimates of heterosis as a deviation from better parent of the fifteen rice crosses for some, yield and its component characters.

Genotypes	Days to complete heading	Plant height (cm)	Panicle length (cm)	No. of panicles /plant	No. filled Grains /panicle	Sterility %	100-grain weight (g)	Grain yield /plant (g)
GZ1368 X Sakha 102	10,52**	4,90**	-1.03	-15,78**	-5,71**	7,14**	0.42	0.31
GZ1368 X Sakha 103	2.01	-7,36**	4,76**	-10.23**	-0,71	14,28**	-3,84**	2,56*
GZ1368 X Sakha 106	1.01	3.26**	-8,66**	-4,54**	6,84**	8,33**	0.79	-2,38*
GZ1368 X Giza 176	1,90	2,94*	-1.04	-6,66**	-0,71	7,69**	-11,11**	3,12**
GZ1368 X Giza 177	1,98	-10.11**	-4,54**	21,05**	-2,14	7,14**	-3,84**	5,71**
Sakha 102 X Sakha 103	3,26**	3,15**	-1.02	-1.02	-5,30**	14,28**	-3,84**	10,25**
Sakha 102 X Sakha 106	-6,45**	1.12	4,34**	4,54**	8,90**	8,33**	-3,70**	2,38
Sakha 102 X Giza 176	-13,96**	1,96	5.23**	-5,26**	-1,51	7,69**	-3,84**	22,22**
Sakha 102 X Giza 177	-7,52**	-7,77**	1.01	1.01	-6,06**	7,14**	3,84**	13,88**
Sakha 103 X Sakha 106	1.10	-5,26**	-4,34**	-4,54**	-13,01**	50.12**	-3,70**	-2,38*
Sakha 103 X Giza 176	-3.21**	-1,05	-4,72**	-10.11**	-0,75	33,33**	-3,84**	12,82**
Sakha 103 X Giza 177	2.12	6,31**	-4,54**	5.12**	-5,30**	66,66**	4.11**	10,25**
Sakha 106 X Giza 176	-4.31**	-4.12**	-4,34**	9,09**	-4,79**	0.98	-7,40**	4,76**
Sakha 106 X Giza 177	1.01	-5,55**	9,09**	4,54**	-9,58**	25.12**	-3,70**	-11,90**
Giza 176 X Giza 177	1,98	4,90**	-4,54**	-10,52**	-2,32	7,69	-3,84**	-5,71**

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

Concerning estimates of heterosis for grain quality characters as shown in Table 11, highest significant and positive direction was recorded from two crosses namely, Sakha 102 x Sakha 106 and Sakha 106 x Giza 176. Most rice crosses gave the highest significant and negative for hulling

%, milling %, grain elongation and gel consistence, while Positive highly significant heterosis estimate was obtained for one cross; GZ1368 x Sakha106 (16.17%).

On the other hand nine rice crosses GZ1368 x Sakha 106, GZ1368 x Sakha 103, GZ1368 x Giza 176, GZ 1368 x Giza 177, GZ1368 x Sakha 102, Sakha106 x Giza 177, Sakha106 x Giza 176, Sakha102 x Sakha 106 and Sakha 103 x Sakha 106 showed highly significant and positive direction for gelatinization temperature, while negative highly significant of heteroses was recorded for one cross Sakha 102 x Sakha 103 for amylose content.

From the foregoing discussion, it may be concluded that the crosses, Sakha 103 x Sakha 106, Sakha 103 x Giza 176, Sakha 103 x Giza 177, GZ1368 x Giza 177, Sakha 106 x Giza 176, GZ1368 x Sakha 103 and Sakha 102 x Sakha 106 can be rated as the best crosses based on their heterosis in most of the studied traits including grain yield. Thus, it can be exploited in subsequent generations to improve most of the studied traits. Similar results were reported by several scientists like, Zhen *et al.* (2004), Jin *et al.* (2005), Faiz *et al.* (2006), Shanthala *et al.* (2006), Paradhan *et al.* (2006)., Radish *et al.* (2007), Abd EL-lattef et al (2011) and Rahimi1 *et al.* (2010).

Concerning estimates of heterosis for grain quality characters as shown in Table 11, highest significant and positive direction was recorded from two crosses namely, Sakha 102 x Sakha 106 and Sakha 106 x Giza 176. Most rice crosses gave the highest significant and negative for hulling %, milling %, grain elongation and gel consistence, while Positive highly significant heterosis estimate was obtained for one cross; GZ1368 x Sakha106 (16.17%).

On the other hand nine rice crosses GZ1368 x Sakha 106, GZ1368 x Sakha 103, GZ1368 x Giza 176, GZ 1368 x Giza 177, GZ1368 x Sakha 102, Sakha106 x Giza 177, Sakha106 x Giza 176, Sakha102 x Sakha 106 and Sakha 103 x Sakha 106 showed highly significant and positive direction for gelatinization temperature, while negative highly significant of heteroses was recorded for one cross Sakha 102 x Sakha 103 for amylose content.

From the foregoing discussion, it may be concluded that the crosses, Sakha 103 x Sakha 106, Sakha 103 x Giza 176, Sakha 103 x Giza 177, GZ1368 x Giza 177, Sakha 106 x Giza 176, GZ1368 x Sakha 103 and Sakha 102 x Sakha 106 can be rated as the best crosses based on their heterosis in most of the studied traits including grain yield. Thus, it can be exploited in subsequent generations to improve most of the studied traits. Similar results were reported by several scientists like, Zhen *et al.* (2004), Jin *et al.* (2005), Faiz *et al.* (2006), Shanthala *et al.* (2006), Paradhan *et al.* (2006)., Radish *et al.* (2007), Abd EL-lattef et al (2011) and Rahimi1 *et al.* (2010).

e. Estimates of genetic variance, heritability and expected genetic advance:

It is clear from Table (12) that Heritability in broad sense estimates (h2b.) was larger than their corresponding ones of narrow sense heritability (h2n.) for all studied characters. High broad sense heritability (93.24%, 92.45 % and 91.24 %) was estimated for number of panicles / plant, panicle length and hulling % respectively. It was found to be moderate (74.63%) for amyls content % to high (91.11%) for days to complete heading. High narrow sense heritability was recorded for hulling % (52.34%). While it was ranged from low to moderate, in other remaining grain yield and gain quality traits. The variation among the heritabilities in both broad and narrow sense values might be due to either gene expression of the trait. The results also revealed that the magnitude of heritability in narrow sense was lower than its corresponding for all studied characters, suggesting the increase contribution of additive gene effect. Additive gene affects increased in the subsequent generation, which help the breeders to select the best genotypes in this generation. So, these materials could successfully be used in the rice breeding program.

The highest estimates of expected genetic advance were observed for days to complete heading (23.25%), panicle length (21.45%), milling % (20.47%) and gelatinization temperature (20.38%). While the low estimates (11.31%) was detected for head rice %, indicating that additive genetic variance played an important role in the inheritance of these traits. Moreover, low to moderate estimates of heritability in narrow sense, accompanied with low to moderate expected genetic advance were recorded for most of the studied traits, lead to conclude that effectiveness of selection of most studied traits might be practiced in the advanced generations. These results ware in harmony with those of El-Abd (2003), Hammoud *et al.* (2006) Abd El-Lattef and Badr (2007) and Abdel-latef *et al.,* (2011).

f. Estimates of genetic variance, heritability and expected genetic advance:

It is clear from Table (12) that Heritability in broad sense estimates (h2b.) was larger than their corresponding ones of narrow sense heritability (h2n.) for all studied characters. High broad sense heritability (93.24%, 92.45 % and 91.24 %) was estimated for number of panicles / plant, panicle length and hulling % respectively. It was found to be moderate (74.63%) for amyls content % to high (91.11%) for days to complete heading. High narrow sense heritability was recorded for hulling % (52.34%). While it was ranged from low to moderate, in other remaining grain yield and gain quality traits. The variation among the heritabilities in both broad and narrow sense values might be due to either gene expression of the trait. The results also revealed that the magnitude of heritability in narrow sense was lower than its corresponding for all studied characters, suggesting the increase contribution of additive gene effect. Additive gene affects increased in the subsequent generation, which help the breeders to select the best genotypes in this generation. So, these materials could successfully be used in the rice breeding program.

The highest estimates of expected genetic advance were observed for days to complete heading (23.25%), panicle length (21.45%), milling % (20.47%) and gelatinization temperature (20.38%). While the low estimates (11.31%) was detected for head rice %, indicating that additive genetic variance played an important role in the inheritance of these traits. Moreover, low to moderate estimates of heritability in narrow sense, accompanied with low to moderate expected genetic advance were recorded for most of the studied traits, lead to conclude that effectiveness of selection of most studied traits might be practiced in the advanced generations. These results ware in harmony with those of El-Abd (2003), Hammoud *et al.* (2006) Abd El-Lattef and Badr (2007) and Abdel-latef *et al.,* (2011).

g.Estimates of phenotypic correlation coefficient:

Phenotypic correlation coefficients among all possible pars of the studied traits are presented in (Table13). Highly significant and positive estimates of phenotypic correlation coefficient were found among grain yield and each of hulling, milling, head rice, grain elongation , gel consistence and gelatinization temperature, while, it was highly significantly and positive associated between 100 grain weight with hulling %, head rice %, gel consistence% and gelatinization temperature. Also number of field grains / panicles was highly significant and positive with hulling milling and head rice %. On the contrary sterility % was negatively correlated with hulling %, milling % and head rice %. However, insignificant either positive or negative estimates of phenotypic correlation coefficient were recorded among other remaining traits. These results were in agreement with those of Abd- Allah (2000), Abd El-Lattef *et al.* (2006) El-Abd *et al.* (2007) and Abdel-latef *et al.,* (2011).

Table (11): Estimates of heterosis as a deviation from better parent of the fifteen rice crosses for some, grain quality characters.

Genotypes	Grain Shape %	Hulling %	Milling %	Head Rice %	Grain Elong. %	Gel *consisten cyyyy* Gel Consistence	Gelatin ization Tempe rature	Amylose content %
GZ1368 X Sakha 102	1.11	-1,21	-1,36	-1,51	-2,24*	-2,24*	9,25**	42,26**
GZ1368 X Sakha 103	1.03	-2,43*	1.10	-3,03**	-4,30**	-4,30**	14,81**	11,11**
GZ1368 X Sakha 106	1.21	1,21	1,36	16,17**	-3,15**	-3,15**	18,51**	31,95**
GZ1368 X Giza 176	-4,16**	-1,21	-2,73**	-1,51	-3,19**	-3,19**	12,96**	15,78**
GZ1368 X Giza 177	-4,16**	-8,53**	1.01	-2,94**	-8,04**	-8,04**	12,96**	36,11**
Sakha 102 X Sakha 103	1.32	1.11	-1,40	-1,56	-2,15*	-2,15*	1,61	-11,11**
Sakha 102 X Sakha 106	3,84**	1,23	1,38	1,47	-1,05	-1,05	3,22**	5,56**
Sakha 102 X Giza 176	-8,33**	1.10	-1,38	-1,53	-1,06	-1,06	-1,61	11,11**
Sakha 102 X Giza 177	-8,33**	-5.11**	-4,10**	-4,47**	-1,12	-1,12	-3,22**	11,11**
Sakha 103 X Sakha 106	-3,84**	-1,23	1.02	-4,41**	-1,05	-1,05	3,07**	1.02
Sakha 103 X Giza 176	-4,34**	1.02	-1,38	1.01	-1,06	-1,06	1,61	5,55**
Sakha 103 X Giza 177	-4,34**	-5,06**	-1,36	-1,49	-11,82**	-11,82**	1,63	5,55**
Sakha 106 X Giza 176	3,84**	1,23	1,38	1,47	-1,05	-1,05	3,22**	1.01
Sakha 106 X Giza 177	-3,84**	-1,23	-2,73**	1.02	-5,26**	-5,26**	3,27**	5,26**
Giza 176 X Giza 177	1.01	-5.12**	-1,36	-1,44	-2,12	-2,12	1.01	5,26**

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

Table (12): Estimates of broad (h^2b) and narrow (h^2n) sense heritability' % and expected genetic advance (GS %) for grain yield and grain quality characters.

Characters	h^2b	h^2n	GS%
Days to complete heading (days)	95.11	33.64	23.25
Plant height (cm)	86.14	35.34	20.63
Panicle length (cm)	92.45	42.36	21.45
No. of panicles /plant	93.24	44.24	19.74
No. of filled grains /panicle	89.71	34.29	11.63
Sterility %	88.47	39.27	15.84
100-grain weight(g)	83.26	39.78	20.63
Grain yield/plant	77.41	41.23	18.63
Grain Shape%	88.75	39.26	19.35
Hulling %	91.24	52.34	18.72
Milling %	84.36	32.36	20.47
Head Rice %	79.32	30.25	11.31
Grain Elongation %	83.62	39.72	19.28
Gel Consistence	89.72	29.74	17.63
Gelatinization Temperature	81.73	35.63	20.38
Amyls content %	74.63	29.74	13.62

Table (13):Estimates of phenotypic correlation coefficients among between grains yield and grain quality characters.

Characters	Hulling %	Milling %	Head Rice %	Grain Elongation %	Gel Consistence Gel Consistence Gel Consistence	Gelatinization Temperature	Amyls content %
Plant height (cm)	0.25	0.10	0.30	0.27	0.11	0.14	0.28
Panicle length (cm)	0.21	0.22	0.21	0.11	0.21	0.16	0.23
No. of panicles /plant	0.29	0.21	0.11	0.19	0.26	0.24	0.26
No. of filled grains /panicle	0.42**	0.40**	-0.52**	0.28	0.28	0.21	0.21
Sterility %	0.40**	-0.32*	-0.49**	0.19	0.24	0.29	0.13
100-grain weight(g)	0.39**	0.29	0.41**	0.20	0.45**	0.38**	0.19
Grain yield/plant	-0.36**	-0.42**	-0.83**	0.38**	0.39**	0.40**	0.29

From the obtained results we can recommend using GZ 1368, Sakha 106, Sakha 102 and Sakha 103 in hybrid programs where those parents showed superiority, respectively to the other parents of traits under the study, and we can use the resulted hybrids of this study in breeding programs.

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السلوك الوراثي للشكل الظاهرى والمحصول ومكوناته وصفات جودة الحبوب في الأرز.

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أجريت دراسة لتقدير القدرة على التآلف وقوة الهجين مقارنة بأفضل الآباء لمحصول الحبوب باستخدام نظام الهجن التبادلية بين ستة تراكيب وراثية مختلفة وذلك بدون الهجن العكسية، بمحطة البحوث الزراعية بسخا وذلك خلال موسمى ٢٠١٢ و٢٠١٣ وذلك بهدف اختيار أفضل التراكيب الوراثية لاستخدامها فى برامج التربية .

وكانت أهم النتائج المتحصل عليها كالآتى:-

كانت هناك معنوية عالية لكل من القدرة العامة والخاصة على التآلف فى معظم صفات المحصول ومكوناته وصفات الجودة مما يدل على أهمية الفعل المضيف وغير المضيف فى توارث هذه الصفات. كما أوضحت النتائج أن النسبة بين كل من تباين القدرة العامة على التآلف إلى تباين القدرة الخاصة على التآلف أعلى من الواحد مشيرة إلى أهمية الفعل المضيف للجين فى التحكم فى كل الصفات تحت الدراسة ما عدا صفات طول الدالية وعدد الحبوب الممتلئة ودرجة الجلتنة للحبوب حيث تأثرت بالفعل السيادى للجين مما انعكس على السلوك الوراثى لتلك الصفات. سجلت التراكيب الوراثية جى زد ١٣٦٨ وسخا ١٠٦ وسخا ١٠٢ وسخا ١٠٣ كأفضل الآباء قدرة عامة على التآلف لمعظم الصفات تحت الدراسة وكذلك الهجن الناتجة من هذه الآباء.كما سجلت ستة هجن جى زد ١٣٦٨ x جيزة ١٧٧ وسخا ١٠٦ x جيزة ١٧٦ وسخا ١٠٢ x جيزة ١٧٧ وسخا ١٠٢ x سخا ١٠٦ وجى زد ١٣٦٨ x سخا ١٠٣ وجيزة ١٧٦ x جيزة ١٧٧ أعلى قدرة خاصة على التآلف لمحصول الحبوب/نبات. تراوحت قوة الهجين بين (٢.٣٨ – ١٣.٨٨ %) فى عدد ستة هجن هى سخا ١٠٣ x سخا ١٠٦ وجى زد ١٣٦٨ x جيزة ١٧٦ وسخا ١٠٣ x جيزة ١٧٧ وجى زد ١٣٦٨ x جيزة ١٧٧ وسخا ١٠٦ x جيزة ١٧٦ وجى زد ١٣٦٨ x سخا ١٠٣ وسخا ١٠٢ x سخا ١٠٦ لصفات المحصول والجودة.

وبناءً على النتائج التى تم التحصل عليها يمكن التوصية باستخدام جى زد ١٣٦٨ وسخا ١٠٦ وسخا ١٠٢ وسخا ١٠٣ فى برامج التهجين حيث أظهرت تلك الآباء تفوقاً على باقى الآباء للصفات تحت الدراسة على التوالى، وبذلك يمكن الاستفادة من الهجن الناتجة تحت الدراسة فى برامج التربية.