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Research Article

General and Specific Combining Ability for Yield and Its Components of Some Rice Genotypes Under Saline Soil Conditions

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Abstract:

present investigation was carried out at Sakha agricultural research station, Kafr El-Sheikh and clayey saline soil at the experimental farm of El-Sirw Agricultural Research Station, Damietta governorate (31°14′N and 31°48′E) at the northern east of the Delta, Agriculture Research Center, Egypt, during 2021 and 2022 seasons. Four lines, Giza178, Giza179, GZ 9399-4-1-1-3-2-2, and Sakha super 300, as a female lines and four testers IET 1444 , Sal 010, GZ 1368 and IR 45427 as male lines were utilized. The selected varieties were crossed by using line & tester's analysis and sixteen crosses were obtained. F1 and their parental lines were grown and evaluated under saline soil condition. The data were collected on No of panicles/plant, panicle weight and length (cm), number of filled grains/panicle, sterility percentage/ (%), 1000-grain weight (gm.), grain yield/plant (gm/plant) and harvest index (%). The obtained results indicated that, the lines, Giza178 and Giza179 were the best general combiner for most of studied traits. Meanwhile, the crosses, Giza179×IR45427, Giza178×IET 1444 and Giza179× Sal 010 were the best performing crosses under saline soil conditions and could be used as the most effective for getting promising hybrids. From the results for genetic parameters, the GCA was more than SCA for grain yield and harvest index, so, could be concluded that, the additive genetic variance plays important role in the inheritance for grain yield and harvest index characters, in this case suggest, pedigree method will be effective to develop new promising lines from these crosses under saline soil condition.

1. Introduction

Rice is one of the most important food crops in the world and a primary source of food for more than half of the world population. In Egypt, rice is considered the second most important cereal crop after wheat and one of the main agriculture products for income of the farmers. The total cultivated area by rice in Egypt is about 465 thousand hectares produced 4.32 million tons of paddy rice with national average yield 9.244 t/ha. (EAS 2022).

In general, rice plants are very sensitive to salinity stress at young seedling stages and during reproduction (Walia et al., 2005)

The loss of farmland due to salinization is directly in conflict with the needs of the world population. Nearly 20 percent of the world`s cultivated area (800 M ha) and nearly half of the world's irrigated lands are affected by salinity (Zhu et al., 2001 and Maser et al., 2002). Furthermore, 50% of the cultivated rice area in Egypt is salt-affected soil in which rice production is dramatically limited and it needs more improvement (Zayed et al., 2019).

The restriction of rice productivity in salt-affected areas can be addressed through an integrated approach involving both reclamation and management strategies, as well as improved genetic tolerance. However, management practices are not always feasible in the long run, as in coastal areas where salt stress is seasonal or in lands where reclamation costs are prohibitive. In both cases, developing salt-tolerant varieties seems more suitable to enhance the productivity of these marginal lands. Rice is recommended as a crop best suited for salt affected soils because it can grow well under flooded conditions that can help in leaching harmful salts (Ismail et al., 2008).

To breed self-pollinated and cross-pollinated crops, as well as to determine the favorable parents and crosses, besides their general and specific combining abilities, the line x tester analysis method is applied (Aslam et al., 2014; Rahaman, 2016).

Therefore, gathering information on the nature of gene effects and their expression in terms of combining ability is necessary. Combining ability identifies potentially superior parents and hybrids, which helps to describe the pattern of gene effects in the expression of quantitative traits (Zhang et al., 2015).

The present research work was carried out with the objectives of assessing combining ability based on mean performance, genetic components for Yield and Its Components in rice to help in the selection of best genotypes

and assist in the choice of breeding strategies for the improvement of salinity tolerance in rice.

2. Materials and Methods

This investigation was carried out in Agriculture Research Station farm, Rice Research and Training Center (RRTC), Sakha (Kafr El-Sheikh governorate) and El-Sirw (Damietta governorate), Egypt, during 2021 and 2022 rice growing seasons. The main objective of the study is assessing combining ability for Yield and Its Components in rice under salinity condition.

In 2021 growing season, the eight rice varieties, four lines, Giza178, Giza179, GZ 9399-4-1-1-3-2-2, and Sakha super 300, as a female lines and four testers IET 1444, Sal 010, GZ 1368 and IR 45427 as male lines were sown at three intervals to get synchronization of flowering. After thirty days, seedlings of each variety were individually transplanted in the experimental field in two rows, 5 meters long and 20 x 20 cm apart between plants and rows. At flowering stage, the four lines were crossed with four testers to produce 16 F1 crosses using bulk emasculation method according to Butany (1961) using hot water (42-44 °C for 10 min).

In 2022 seasons, seeds of the lines and testers, as well as their possible sixteen crosses were sown at May 1st in the nursery and seedlings were transplanted after 30 days from sowing in a Randomized Complete Block Design experiment (RCBD), with three replications. Each cross consisted of three rows for each parent and F1, the row was five meters in length with 20 cm. between rows and hills. All recommended agriculture practices for growing rice production under the saline effected soil were applied.

The grain yield and its components were estimated according to IRRI standard evaluation system (SES) (IRRI, 2016). For subsequent measurements of the following traits: number of panicles /plant, panicle weight and length, number of filled grains panicle-1, sterility (%), 1000-grain weight (g), grain yield /plant and harvest index (%). The collected data were analyzed for analysis of variances according to Gomez and Gomez (1984).

the analysis of variance for line x tester crossing design as suggested by (Kempthorne, 1957).

3. Results and discussion

The results of the analysis of variance and mean squares for the eight rice varieties and 16 F1 hybrids for yield and yield components are presented in Table (1) revealed that, highly significant differences were recorded among genotypes, parents, crosses, parent vs. crosses, GCA and SCA for most of yield and its components traits i.e., number of panicle per plant, panicle length, panicle weight, number of filled grains per panicle, spikelet's sterility %, 1000-grain weight, grain yield per plant and harvest index %. It could be noticed that the mean squares of genotypes, parents and crosses showed highly significance for grain yield and its component characters. These findings indicated overall wide differences among these genotypes. At the same time, the mean squares of Parents vs. crosses were found to be highly significant for grain yield and its component characters.

Both general and specific combining ability variance were found to be significant and highly significant for all traits, indicating the importance of both additive and non-additive genetic variance in determining the performance of these traits. These findings are in agreement with those reported by Utharasu and Anandakumar (2013), Veeresha et al. (2015).

GCA/SCA ratios were found to be more than unity for all yield traits except No. of panicles/plant, panicle length and 1000 grain weight, indicating that the additive type of gene action was greater importance in the inheritance of these traits. It suggested greater importance of additive gene action in their expression and indicated very good prospect for the exploitation of additive genetic variation for all yield traits through pedigree rice breeding. On the other hand, the non-additive type of gene action was greater importance in the inheritance for the remaining traits which similar to reported by El-Badawy (2009), Anis (2009) and Pandey (2012). Importance of non-additive genes for expression of different traits .

Mean performances values of the eight rice varieties and their F1 crosses (16 crosses) for the yield and its components traits such as; number of panicles per plant, panicle length, panicle weight, number of filled grains per panicle, sterility percentage, 1000-grain weight, grain yield per plant and harvest index during 2022 season are shown in Table (2).

For number of panicles per plant ,the lines Super rice 300, GZ 9399 and Giza178 recorded the highest values, (17.63, 17.62 and 17.33) panicles per plant respectively), while, the highest values for the crosses were obtained from the crosses Giza179*GZ 1368, Giza179*IET1444, GZ 9399*Sal010 and GZ9399*IET1444, the values were (23.67, 22.67, 21.67 and 21.33 panicles per plant respectively). On the other side, the lowest values for number of panicle per plant were recorded for the tester line IR45427 gave the value of (13.43panicles per plant), and the crosses Super rice 300*IET1444, Super rice 300*GZ 1368 and Super rice 300*Sal010 (13.33, 14.00 and 14.00 panicles per plant respectively).

Concerning panicle length, the desirable mean values for panicle length were recorded by the lines Super rice 300 and Giza178 with values of (21.40 and 19.33 cm respectively) and three crosses; Super rice 300*IR45427, Giza179*Sal010 and Giza178*IR45427 with values of (29.23, 26.67, and 26.63 cm respectively), while the undesirable mean values for panicle length were recorded of the line Giza9399 with value of (12.33 cm respectively) and four crosses; Giza178*IET1444, GZ 9399*GZ 1368, GZ 9399*IET1444 and Giza179*GZ 1368 with values of (19.67,21.73,21.87 and 21.87 cm respectively)

Regarding, panicle weight, the data in Table (2)

showed that the lines, Super rice 300 and GZ 9399 recorded the highest desirable panicle weight among lines (2.73 and 2.63 g respectively), but the lines, Giza178 and Giza179 exhibited the lowest mean values (1.94 and 1.95 g respectively).

On the other hand, it was found from the date obtained in Table (2) that, the crosses Giza178*GZ 1368, Giza179*IET1444 and Giza178*IR45427 (showed the highest desirable panicle weight comparing with other crosses (4.70, 4.64 and 4.61 g respectively). In contrast, the lowest values for panicle weight were recorded for the crosses Super rice 300*GZ 1368, Super rice 300*IR45427 and Super rice 300*IET1444 (2.44, 2.55 and 2.93 g respectively).

With regard to the 1000-grain weight character, data presented in Table (2) indicated that, the lines Super rice 300 and GZ 9399 recorded the highest desirable mean values for 1000-grain weight comparing with other lines (26.23 and 25.97 g respectively),

S.O.V	DF	No. of panicles	panicle length (cm)	panicle weight (g)	1000 grain weight (g)	No. of filled grain/panicle	sterility %	Grain yield/ plant(g)	Harvest Index (%)
Reps	2	0.15	0.92	0.02	0.08	1.75	4.59	1.277	1.176
Genotypes (G)	23	25.40**	49.47**	3.36**	13.01**	3993.1**	976.38**	375.24**	232.89**
Parents (P)	7	6.32**	24.80**	0.45**	22.50**	51.92**	63.95**	12.93**	11.18**
Crosses (Cr)	15	31.53**	17.791**	1.85**	4.84**	2780.5**	1463.35**	123.74**	176.76**
Pa vs. Cross	1	67.04**	697.4**	46.3**	69.01**	49770.6**	58.93**	6683.88**	2626.71**
Lines (L)	3	125.3**	19.59**	8.79**	10.31**	12987.2**	7297.67**	588.18**	834.56**
Testers (T)	3	1.111	42.491**	0.03	4.92**	320.73**	8.45**	13.36**	5.80**
L x T	9	10.40**	8.95**	0.15**	2.99**	198.25**	3.53**	5.73**	14.49**
Error	46	1.55	0.68	0.21	0.31	5.16	2.67	1.9	1.67
GCA	7	0.73**	0.31**	0.05*	0.06*	89.66**	6.69**	4.09**	5.63**
SCA	15	3.28**	2.76**	0.04*	0.89*	64.36**	0.95*	1.61**	4.61**
GCA/SCA		0.248	0.115	1.76	0.057	1.51	7.01	5.64	1.42

Table 1: Estimates of the mean square of line x tester analysis for yield and its components during 2022 season.

*and ** significant and highly significant at 0.05 and 0.01 , respectively

while the crosses; Super rice 300*Sal010 and Giza179*Sal010 recorded the highest desirable mean values for 1000-grain weight comparing with other crosses (27.23 and 26.50 g respectively). In contrast, the lowest undesirable mean values for 1000-grain weight were recorded by the line Giza178 (19.63 g), and the crosses Giza178*IR45427, Giza178*Sal010, Giza178*IET1444 and Giza178*GZ1368 (22.50, 23.18, 23.23 and 23.43 g respectively).

In respect to number of filled grains per panicle, the lines Super rice 300 recorded the highest mean values for number of filled grains per panicle comparing with other lines (89.24 grains), but the combinations Giza178*IR45427, Giza179*IET1444, Giza178* Giza1368 and Giza179*IR45427 recorded the highest mean values for number of filled grains per panicle comparing with other crosses (179.67, 167.67, 164.67 and 161.67 grains respectively), while the lowest values for number of filled grains per panicle were recorded for the tester; IR45427 and Sal010 (78.95 and 80.15 grains respectively) and the crosses; Super rice 300*IET1444 , Super rice 300*Sal010, Super rice 300*IR45427, and Super rice 300*GZ 1368 (88.00, 91.00, 91.21 and 95.33 grains respectively).

For sterility percentage, from data presented in Table (2) it could be observed that; among lines, the GZ 9399, Giza179 and Super rice 300 showed the most desirable values of sterility percentage which is (12.57, 13.93 and 13.94 respectively), while, the tester Sal010 showed the highest value of sterility percentage- which is undesirable values - comparing to other parents (25.88 and 21.08 % respectively). On the other hand, among crosses, Giza178*GZ 1368, Giza179*GZ 1368, GZ 9399*IET1444 and Giza179*IR45427 showed the most desirable values percentage comparing with other crosses (5.17, 5.43, 5.55 and 5.84 % respectively). For the highest values of sterility percentage we could notice from the data in the Table (2) that all crosses which resulted from the cross line super rice300 as japonica type with Indica or Indica/japonica type recorded high sterility percentage and ranged from 57.00% for the cross (Super rice 300*Sal010) to 53.22 % for the cross (Super rice

300*IET1444. That indicated the sterility percentage which could be classified to three levels; lower in japonica x japonica crosses then indica x indica crosses and higher in indica x japonica crosses. and that confirms the lowest number of filled grains for these crosses which resulted from the varieties Giza179 with IR 45427.

Concerning to Grain yield per plant, data in Table (2) showed that the line IET1444 recorded the highest grain yield per plant comparing with other parents (25.90 g) followed by GZ 9399(24.84g), while the tester Sal010 other hand, the highest grain yield per plant for crosses recorded the lowest value for grain yield per plant comparing with other parents (19.35 g per plant). On the other hand, the highest grain yield per plant for crosses was recorded for the combinations Giza179*IET1444, Giza179*GZ 1368, Giza179*Sal010 and Giza179*IR45427 (50.96, 50.56, 48.93 and 48.89g per plant respectively), whereas, the lowest grain yield per plant were recorded of the combinations Super rice 300*GZ 1368, Super rice 300*IR45427 and Super rice 300*Sal010 (31.22, 31.55 and 33.03 g respectively).

Table 1: The mean performances of all genotypes for yield and its components during 2022 season.

Genotypes	No. of panicles	panicle length (cm)	panicle weight (g)	1000 grain weight (g)	No. of filled grain/ panicle	sterility %	Grain yield/ plant (g)	Harvest Index (%)
Lines								
Giza178	17.33	19.33	1.94	19.63	85.98	21.08	23.33	33.8
Giza179	15.79	16.73	1.95	22.78	83.23	13.93	20.98	31.06
Super rice 300	17.63	21.40	2.73	26.23	90.87	13.94	21.85	32.18
GZ 9399	17.62	12.33	2.63	25.97	82.38	12.57	24.84	29.38
Mean	17.09	17.45	2.31	23.66	85.62	15.38	22.75	31.60
Testers								
IET1444	16.76	18.70	2.78	22.80	89.24	17.50	25.90	35.80
GZ 1368	15.11	17.50	2.52	22.03	84.78	16.78	22.88	31.59
Sal010	15.95	16.52	1.86	18.58	80.15	25.88	19.35	31.50
IR45427	13.43	14.19	2.09	20.86	78.95	13.10	22.89	31.46
Mean	15.31	16.73	2.31	21.07	83.28	18.42	22.76	32.59
Hybrids								
Giza178*IET1444	15.00	19.67	4.32	23.23	156.00	6.08	44.68	42.54
Giza178*GZ 1368	16.00	23.07	4.70	23.43	164.67	5.17	45.15	45.78
Giza178*Sal010	18.00	25.23	4.35	23.18	142.67	6.67	44.12	47.76
Giza178*IR45427	17.33	26.63	4.61	22.50	179.67	7.87	44.77	49.25
Giza179*IET1444	22.67	23.03	4.64	23.90	167.67	6.02	50.96	53.21
Giza179*GZ 1368	23.67	21.87	4.57	24.50	154.00	5.43	50.56	52.37
Giza179*Sal010	20.00	26.67	4.21	26.50	152.00	6.30	48.93	52.20
Giza179*IR45427	20.00	25.23	4.38	25.67	161.67	5.84	48.89	51.56
Super rice 300*IET1444	13.33	23.17	2.93	24.73	88.00	53.22	37.45	32.50
Superrice300*GZ 1368	14.00	22.47	2.44	24.59	95.33	56.95	31.22	34.52
Super rice 300*Sal010	14.00	24.97	3.01	27.23	91.00	57.00	33.03	34.03
Super rice 300*IR45427	17.00	29.23	2.55	23.11	91.21	55.84	31.55	30.90
Giza9399*IET1444	21.33	21.87	4.37	24.33	150.67	5.55	45.95	49.23
GZ 9399*GZ 1368	18.00	21.73	4.46	24.22	151.33	6.67	44.52	50.35
GZ 9399*Sal010	21.67	22.10	4.42	24.67	147.33	8.79	44.17	46.81
GZ 9399*IR45427	20.00	22.10	4.26	25.20	150.33	6.88	45.13	45.52
Mean	18.25	23.69	4.01	24.44	140.22	18.92	43.19	44.91

G. Mean		17.57	21.49	3.45	23.75	121.63	18.13	36.38	40.64
LSD	0.05	1.222	1.360	0.187	0.921	3.734	1.345	1.559	1.348
0.01		1.631	1.816	0.250	1.229	4.985	1.796	2.081	1.800

In respect to harvest index, as shown in Table (2), the tester IET1444showed the highest values for harvest index among the other testers (35.80 %) followed by the lines Giza178 and Super rice 300 (33.8 and 32.18 % respectively), while the highest values for harvest index among the crosses were observed of the cross Giza179*IET1444 (53.21%) followed by the crosses Giza179*GZ 1368, Giza179*Sal010 and Giza179*IR45427 (52.37, 52.20 and 51.56 % respectively). In contrast, the lowest values in harvest index were recorded for the lines GZ 9399 and Giza179 (29.38 and 31.06 % respectively), and the crosses Super rice 300*IR45427, Super rice 300*IET1444, Super rice 300*Sal010, and Super rice 300*GZ 1368 (30.90, 32.50, 34.03 and 34.52 respectively).

From the data in Table (2), it could be noticed that these crosses gave the lowest values of harvest index because it was lowest for number of filled grains, fertility percentage and grain yield per plant, which referred to absent WC genes.

Significant differences of GCA were observed among the eight rice varieties for the Yield and its component traits shown in Table (3) such as; number of panicles per plant, panicle length, panicle weight, number of filled grains per panicle, sterility (%),1000-grain weight, grain yield per plant and harvest index during 2022 season.

For number of panicles per plant, the data appeared in Table (3) showed that the GCA estimates were highly significant and either positive or negative for most parental lines. Table (3) showed that Highly significant and positive GCA was recorded for the lines Giza179 and GZ 9399 (3.33 and 2.00 respectively), so Giza179 and GZ 9399 were the best combiner for number of panicles per plant followed by the testers IR45427 and Sal010 (0.33 and 0.17 respectively), On the other side all the ~~o~~thers lines and testers showed negative and undesirable GCA effects.

Concerning to panicle length, among the eight rice varieties, only the line Super rice 300 and tester IR45427, Sal010 showed highly significant positive estimate of GCA effect which recorded value of (1.27, 2.11 and 1.05 respectively), and Giza179 showed significant positive estimate of GCA effect (0.51). The other three lines of them showed a highly significant negative (undesirable) estimate of GCA, while the other testers showed non-significant estimate of GCA. as it clear in Table (3).

As for panicle weight trait, the three lines Giza178, Giza179 and GZ 9399 were recorded the highest significant and positive estimate of GCA effect (0.48, 0.44 and 0.36 respectively), while, Super rice 300 showed highly significant and negative (undesirable) estimates of GCA (-1.28), the other four testers showed non-significant estimates of GCA as shown in Table (3).

With respect to 1000-grain weight trait, the results in Table (3) revealed that the estimates of GCA effects were highly significant and positive (desirable) for two lines Giza179 and Super rice 300 varieties showed highly significant positive values of GCA for 1000-grain weight with the values of (0.70 and 0.48 respectively), as it shown in Table (3).

Concerning the number of filled grain per panicle, Table (3) showed highly significant positive estimates of GCA effect and the highest values were (20.53and 18.61), which were recorded for the lines Giza178 and Giza179 respectively, followed by the testers GZ 9399 and IR45427 that gave the values of (9.70 and 5.50 respectively), indicating that these entries appeared to be good combiners in rice crosses for improving this trait, while the line Super rice 300 and tester Sal010) recorded significant negative and undesirable estimates of GCA effect for number of filled grain per panicle trait, As shown in Table (3).

Regarding sterility percentage character, the results in Table (3) revealed that the estimates of GCA effects were highly significant and either positive or negative for lines and testers, showed highly significant and positive (undesirable) estimates of general combining ability effects, but the other lines and testers exhibited highly significant and negative (desirable) estimates of general combining ability effects, Giza179, Giza178 and GZ 9399 showed the highest significant negative values were of (-12.87, -12.32 and -11.80 respectively), followed by IET1444 with the value of (-1.05), as it shown in Table (3).

For grain yield per plant, from the results in Table (3) the estimate for grain yield was highly significant and positive for three lines, Giza179 followed by the GZ 9399, and Giza178 were the best combiners for grain yield per plant, they exhibited (6.64, 1.75, 1.57 and 1.49 respectively). However, the positive values of GCA mean increased for grain yield per plant which could be useful in breeding programs for high grain yield potential of rice cultivars. Same results were obtained by El-Naem (2010) and El-Sherif (2011).

Concerning the harvest index trait,Giza179 and GZ 9399 were the best combiners with positive estimates, as shown in Table (3). Furthermore, data indicated that the GCA estimate for harvest index trait was highly significant and positive of the lines Giza 179 and GZ 9399 (7.43 and 3.07 respectively), followed by the line Giza 178 which gave the value (1.42).

Therefore, it may be concluded that crosses involving these parents would result in the identification of superior sergeants with favorable genes for grain yield and its related investigation. High GCA effects are related to

additive and additive x additive components for 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 in case of earliness, short stature and sterility %. Similar results were obviously recorded by Abd El-Aty et al. (2016).

Table 3: Estimate of GCA effects (gi) of lines and testers for yield and its components during 2022 season

Genotypes	No. of panicles	panicle length (cm)	panicle Weight (g)	1000 grain weight (g)	No. of filled grain/ panicle	sterility %	Grain yield/ plant (g)	Harvest Index (%)
				Lines				
Giza178	-1.67**	-0.04	0.48**	-1.35**	20.53**	-12.32**	1.49**	1.42**
Giza179	3.33**	0.51*	0.44**	0.70**	18.61**	-12.87**	6.64**	7.43**
Super rice 300	-3.67**	1.27**	-1.28**	0.48**	-48.84**	36.98**	-9.88**	-11.92**
GZ 9399	2.00**	-1.74**	0.36**	0.17	9.70**	-11.80**	1.75**	3.07**
				Testers				
IET1444	-0.17	-1.76**	0.05	-0.39*	0.36	-1.05**	1.57**	-0.54*
GZ 1368	-0.33	-1.41**	0.03	-0.25	1.11	-0.21	-0.33	0.85**
Sal010	0.17	1.05**	-0.02	0.96**	-6.97**	0.92**	-0.63*	0.29
IR45427	0.33	2.11**	-0.07	-0.32	5.50**	0.34	-0.61*	-0.60*
L.S.D. for lines	-	-	-	-	-	-	-	-
0.05	0.432	0.481	0.067	0.325	1.320	0.476	0.551	0.477
0.01	0.577	0.642	0.089	0.434	1.762	0.635	0.736	0.636
L.S.D. for testers	-	-	-	-	-	-	-	-
0.05	0.432	0.481	0.067	0.325	1.320	0.476	0.551	0.477
0.01	0.577	0.642	0.089	0.434	1.762	0.635	0.736	0.636

Significant differences of SCA were observed among the sixteen crosses for Yield and its component traits shown in Table (4) such as; number of panicles per plant, panicle length, panicle weight, number of filled grains per panicle, sterility (%), 1000-grain weight, grain yield per plant and harvest index during 2022 season.

Regarding number of panicles per plant trait recorded in Table (4) shows that, six out of the 16 hybrid combinations showed positively significant SCA effects; the best hybrid combiners which recorded the highest positive value were Giza179*GZ 1368 and Super rice 300*IR45427 with values of (2.42 and 2.08 respectively) followed by Giza178*Sal010,Giza179*IET1444, GZ 9399*IET1444 and GZ 9399*Sal010 which recorded the positive and significant values (1.25 for each hybrid). Similar findings were found by Negm (2011) and El-Badri (2013). Indicating Giza 179 was good donor for most studied characters, as mentioned by Abo-Yousef et al. (2023).

With respect to panicle length trait, four hybrids out of the 16 hybrid combinations were positively significant for SCA effect (desirable), these crosses were Super rice 300*IR45427, GZ 9399*IET1444, Giza179*Sal010 and GZ 9399*GZ 1368 the values were (2.16, 1.67, 1.41 and 1.19 respectively), as shown in Table (4).

Concerning panicle weight, as it's clear in Table (4), five crosses out of 16 crosses showed significant positive SCA, Super rice 300*Sal010 had the best positive significant estimates recorded with value of (0.30) followed by Giza178*GZ 1368, Giza178*IR45427, Super rice 300*IET1444 and GZ 179*IET1444 these recorded values of (0.18, 0.18, 0.15 and 0.14 respectively).

With respect to 1000-grain weight trait, results in the Table (4) exhibited that, the hybrid combinations Super rice 300*GZ 1368 and GZ 9399*IR45427 showed the highest significant positive values of SCA, the values of (1.36 and 0.91 respectively), followed by the hybrid Giza179*IR45427 which showed significant positive value, which is (0.84).

Respecting number of filled grains per panicle trait, the results revealed that, six hybrid combinations were positive significant estimates of SCA effect, the highest positive and significant value was recorded with Giza178*IR45427, this cross recorded positive and significant value (13.42) followed by the crosses Giza179*IET1444, Super rice 300*Sal010 and GZ 9399*Sal010 which recorded the values of (8.47, 6.59 and 4.39 respectively). While the crosses Super rice

300*GZ 1368 and Giza178*GZ 1368 recorded the lowest positive estimate of SCA, which recorded the values of (2.84 and 2.80), as the data in Table (4) showed.

Regarding sterility percentage character, the results in Table (4) revealed that, the estimates of SCA effects were significant negative (desirable) for only two crosse, Super rice 300*IET1444 showed highly significant negative value (-1.48), the cross, Giza178*GZ 1368, showed significant negative value (-1.07).

For grain yield per plant, from the results summarized in Table (4) the estimate for grain yield was highly significant and positive for only the cross Super rice 300*IET1444 with the values of (2.57)

Concerning the harvest index trait, data in Table (4) indicated that the SCA estimate of harvest index trait was highly significant and positive for four crosses. Furthermore, the cross Giza178*IR45427 was the best absolute specific combiner with the highest positive estimate of (3.52), followed by the crosses GZ 9399*IET1444, GZ 9399*Giza1368 and Giza179*IET1444 which gave the values of (1.79, 1.53 and 1.41, respectively).

In general, it could be recommended that through the crosses genotypes each cross recorded the highest value for any trait under study, either yield contribution or yield trait, is considered a good combiner for this trait and could be used in breeding programs to develop rice varieties. These results indicated that the possibility to exploit these hybrid combinations in developing hybrid rice varieties. It also indicated that, both additive and non-additive types of gene action play important role for the inheritance of these traits.

Table 4: Estimates of SCA effects (Sij) of hybrid combinations for yield and its components during 2022 season.

Genotypes	No. of panicles	panicle length (cm)	panicle weight (g)	1000 grain weight (g)	No. of filled grain/ panicle	sterility %	Grain yield/ plant (g)	Harvest Index (%)
				Crosses				
Giza178*IET1444	-1.42**	-2.23**	-0.23**	0.53	-5.11**	0.68	-1.56**	-3.25**
Giza178*GZ 1368	-0.25	0.82	0.18*	0.60	2.80*	-1.07*	0.80	-1.40**
Giza178*Sal010	1.25**	0.53	-0.13	-0.86*	-11.11**	-0.70	0.07	1.14*
Giza178*IR45427	0.42	0.87	0.18*	-0.27	13.42**	1.08*	0.70	3.52**
Giza179*IET1444	1.25**	0.59	0.14*	-0.85*	8.47**	1.18*	-0.44	1.41**
Giza179*GZ 1368	2.42**	-0.93	0.09	-0.39	-5.95**	-0.25	1.05	-0.81
Giza179*Sal010	-1.75**	1.41**	-0.23**	0.40	0.14	-0.52	-0.28	-0.43
Giza179*IR45427	-1.92**	-1.08*	0.00	0.84*	-2.66*	-0.40	-0.34	-0.18
Super rice 300*IET1444	-1.08*	-0.04	0.15*	0.20	-3.75**	-1.48**	2.57**	0.05
Super rice 300*GZ 1368	-0.25	-1.09*	-0.33**	-0.07	2.84*	1.41**	-1.76**	0.68
Super rice 300*Sal010	-0.75	-1.04*	0.30**	1.36**	6.59**	0.32	0.35	0.75
Super rice 300*IR45427	2.08**	2.16**	-0.12	-1.49**	-5.68**	-0.25	-1.16*	-1.49**
GZ 9399*IET1444	1.25**	1.67**	-0.06	0.12	0.39	-0.37	-0.56	1.79**
GZ 9399*Giza1368	-1.92**	1.19*	0.05	-0.13	0.30	-0.09	-0.09	1.53**
Giza9399*Sal010	1.25**	-0.90	0.06	-0.90**	4.39**	0.90	-0.14	-1.46**
Giza9399*IR45427	-0.58	-1.96**	-0.05	0.91**	-5.08**	-0.43	0.80	-1.85**
LSD 0.05	0.951	0.962	0.134	0.651	2.640	0.951	1.102	0.953
0.01	1.270	1.284	0.179	0.869	3.525	1.270	1.472	1.273

The estimates of genetic parameters, additive genetic variance (σ^2 A), dominance genetic variance (σ^2 D), environmental variance (σ^2 E), genotype variance (σ^2 G), phenotypic variance (σ^2 P), broad sense heritability (h^2b %), narrow sense heritability (h^2n %), relative importance of GCA% and relative importance of SCA% are presented in Table 5.

The results of additive variance (σ^2 A) and relative GCA % indicated that, these traits were largely governed by additive gene action, while dominance variance (σ^2D) and relative importance of SCA% are defined as including the non- additive genetic portion of total genetic variation arising largely from dominance and epistatic deviation. Pradhan *et al.* (2006) reported that general combining ability (GCA) is attributed to additive gene effects and additive x additive epitasis. On the other hand, specific combining ability is attributable to non-additive gene action that may be due to dominance, epitasis, or both and is non-fixable.

The results clearly indicated that non-additive gene actions play a significant role in controlling the

expression of all the traits except grain yield and harvest index. It could be noticed that the values of additive, dominance and environmental variances varied from trait to another. The dominance component played a great role for all studied traits, whereas the dominance gene action indicated the preponderance of non-additive genes in controlling.

Table 5: Estimates of genetic parameters and heritability in broad and narrow senses for growth and yield and its components during 2022 season

Genetic parameters and heritability	No. of panicles	panicle length (cm)	panicle weight (g)	1000 grain weight (g)	No. of filled grain/panicle	sterility %	Grain yield/ plant (g)	Harvest Index (%)
Additive variance (σ^2A)	2.93	1.23	0.247	0.257	358.65	202.75	16.39	22.54
dominant variance (σ^2D)	13.14	11.03	0.184	3.57	257.46	3.82	6.44	18.43
Genotypic variance (σ^2G)	16.07	12.26	0.42	3.829	616.11	206.58	22.83	40.96
Environmental variance (σ^2E)	0.553	0.685	0.013	0.314	5.162	0.67	0.9	0.673
Phenotypic variance (σ^2P)	16.63	12.94	0.43	4.142	621.27	207.25	23.73	41.64
Broad sense heritability(h^2_b%)	89.57	83.12	92.52	76.51	97.93	99.35	91.60	95.93
Narrow sense heritability (h^2_n%)	27.65	15.12	66.67	9.63	72.06	98.42	76.55	68.10
Relative importance of gca%	18.26	10.01	56.32	6.71	58.21	98.15	71.79	55.02
Relative importance of sca%	81.74	89.99	43.68	93.29	41.79	1.85	28.21	44.98
Contribution Of Lines	79.49	22.02	94.77	42.58	93.41	99.74	95.06	94.42
Contribution Of Testers	0.70	47.77	0.348	20.35	2.31	0.12	2.16	0.66
Contribution Of (L X T)	19.80	30.21	4.88	37.07	4.28	0.15	2.78	4.92

From these results, could be concluded that, the highest grain yield per plant were recorded of the combinations Giza179*IET1444, Giza179*GZ 1368, Giza179*Sal010 and Giza179*IR45427 (50.96, 50.56, 48.93 and 48.89g per plant respectively), as promising hybrids, also, the additive genetic variance play important role in the inheritance for grain yield and harvest index characters, so pedigree method will be effective to develop new promising lines from these crosses under saline soil condition.

4. References

Abd El-Aty, M.S.; Y.S.M. Katta; M.I. Abo-Youssef and M.M. Bahgt (2016). Genetical analysis for some morphological and yield characters in some rice genotypes (oryza sativa L.). The 10th Plant Breeding international Conference September 2016. Egypt. J. Plant Breed. 20 (4):108 -127. 2016 Special Issue

Abo-Yousef, M.I.; Sedeek, S.E.; EL-Rafaee , I.S.; et al., (2023). Giza 179 Egyptian Rice Variety: As New Early, High Yielding , Tolerant to Saline and Climate Change Challenges., international conference of field crops research institute, Egypt. J. Agric. Res.,100(2)567-588

Anis, G. B. (2009). Breeding for earliness and some agronomic characters in rice (*Oryza sativa L.).* M.Sc. Thesis, Fac. Agric. Kafr El-Sheikh Univ., Egypt.

Aslam, R.; Munawarand, M.; Salam, A. (2014). Genetic architecture of yield components accessed through Line x Tester analysis in wheat (*Triticum sativum L.*) Universal Journal of Plant Science, (2), 93-96.

Butany, W. T. (1961). Mass emasculation in rice. International Rice Commission Newsletter 9: 9–13.

Dwivedi D.K. and M.P. Pandey (2012). Gene action and heterosis for yield and associated traits in Indica and tropical Japonica crosses of rice (*Oryza sativa* L.) involving wide compatibility gene(s). Int. J. Plant Breed. and Genet. 6: 140-150.

Economic Affairs Sector (EAS) (2022). Final report for rice productivity in Egypt. Economic Affairs Sector. Ministry of agriculture and land reclamation, Egypt.

El Badawy, O. A. (2009). Genetic studies on improvement of some restorer lines for cytoplasmic genetic male sterile (CMS) lines in rice (Doctoral dissertation, M. Sc. Thesis, Fac. of Agric. Mansoura Univ., Egypt).

El-Badri, A.M.A. (2013). Genetical studies on some rice varieties for resistant to blast disease. M.Sc. Genetics, Fac. of Agric, Mansoura Univ., Egypt.

El-Naem, S, M, A. (2010). Breeding studies on rice (Oryza sativa L.) under water stress conditions. M.Sc. Thesis (Agron), Fac. of Agric, Mansoura Univ., Egypt.

El-Sherif, A.I.A.Z. (2011). Genetic studies on blast disease in rice (*Oryza sativa* L.). M.Sc.; Thesis, Fac. of Agric., Menofiya Univ., Shibin El-Kom, Egypt.

FAO (2019). The state of food insecurity in the world 2019. FAO available at ftp://ftp.fao.org/docrep/fao/012/i0876e/i0876e.pdf

Gomez, K.A. and A.A. Gomez(1984). Statistical procedures for agricultural research. 2nd ed. Jhon Willy Sons, New York, U.S.A., pp. 680.

IRRI (2016). Standard Evaluation System for rice 3rd

Edition, Int. Rice Testing Program.
Ismail, A. M.; Thomson, M. J.; Singh , R. K.; Gregorio, G. B. and Mackill, D. J. (2008). Designing rice varieties adapted to coastal areas of South and Southeast Asia. J Indian Soc. Coastal Agric. Res. 26: 69–73.
Kempthorne, O. (1957).An Introduction to Genetic Statistics. Iohn Wiley and Sons Inc., New York, pp: 458-471.
Maser, P., Gierth, M. and Schroeder, J.I. 2002. Molecular mechanisms of potassium and sodium uptake in plants. Plant and Soil, 247: 43-54.
Pradhan, S. K.; Boss , L. K. and Meher, J. (2006).Studies on gene action and combining ability analysis in Basmati rice. Journal of Central European Agriculture, 7(2): 267-272.
Rahaman, A. (2016). Study of nature & magnitude of gene action in hybrid rice (*Oryza sativa* L.) through experiment of line x tester mating design. International Journal of Applied Research, 2(2), 405-410.
Utharasu, S. and Anandakumar, C. R. (2013). Heterosis and combining ability analysis for grain yield and its component traits in aerobic rice (Oryza sativa L.) cultivars. Electronic J. Pl. Breed., 4(4): 1271-1279.
Veeresha B.A.; Hanamaratti , N.G. and Salimath, P.M. (2015). Heterosis and combining ability studies for yield and productivity Traits in Rice. Inter. J. Current Agric. Res. 4(5):120-126.
Walia, H. et al. (2005). Comparative transcriptional profiling of two contrasting rice genotypes under salinity stress during the vegetative growth stage. Plant Physiol. 139, 822–835.
Zayed, B.A.; Okasha, A. M.; Rashwan, E. (2019). Impact of different rates of phosphoric acid foliar spraying on ricegrowth and yield traits under normal & saline soils conditions. East African Scholars Journal of Agriculture and Life Sciences, 2(2):56-66.
Zhang, X. ; Liangiie, L.V.; Chai, L.V.; Baojian, G.; Rugen, X. (2015).Combining ability of different agronomic traits & yield components in hybrid barley.Plos One 10: 6.
Zhu, G.Y.; Kinet, J.M. and Lutts, S. (2001). Characterization of rice (*Oryza sativa* L.) F3 populations selected for salt resistance. I. Physiological behavior during vegetative growth. Euphytica, 121: 251-263.