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Genetic Analysis of Some Qualitative and Quantitative Traits in Rice (*Oryza sativa* L.)

Cross Mark

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ABSTRACT

The investigation was undertaken to determine the combining ability effects different genetic parameters between some rice genotypes. Line x tester mating design was conducted and 12 F_1 hybrid combinations were developed from the cross between 3 lines and 4 testers. There was significant difference between parents, crosses and line x tester interaction for the tested traits. Sakha106 was the best general combiners for heading date, while the line GZ9399 was the best for yield and its components. Among the testers, GZ10101 line was adjudged as good general combiner for 1000-grain weight trait. The crosses Giza178 x Egyptian Yasmin and Sakha106 x GZ10101 were the best hybrid based on specific combining effects for the most important traits. The dominance genetic variance (σ^2D) was greater than the additive genetic variance (σ^2A) in controlling the inheritance of all the studied traits, except flag leaf area was governed by the additive genetic variance. Heritability values are high for plant height and sterility %, indicating slight effects of environment on the traits. On the contrary, the contributions of the lines were higher than the contribution of the testers for no. of panicles/plants, no. of filled grains/panicle, sterility % and grain yield/plant. Cluster analysis divided the seven rice genotypes and their hybrid combinations into two main groups based on morphological traits especially plant height, no. of filled grains/panicle traits and sterility %. Studying of combining abilities is effective in identifying the better parents and helps in the selection of better parent for successful breeding.

Keywords: Rice, combining ability, genetic parameters, cluster analysis

INTRODUCTION

Rice (*Oryza sativa* L.) is the main food for more than half of the human population and as such it plays a key role in ensuring food security all over the world Yuan, (2014). Rice is the main food cereal crop after wheat for Egyptian population. Rice crop plays a serious role in Egypt, strategy for sustaining the food self-sufficiency and for expanding the export. Under irrigation ecosystem about 0.6 million ha until 2017 the area cultivated annually to rice in Egypt and decreased to 0.32 million ha in 2018. The world population is expected to reach 8 billion by 2030 and rice production must be increased by 50% in order to meet the growing demand for the world Fageria, (2007). Continuously, rice breeders and producers looking for development of new rice lines which increase rice production with adapting for climate change. Despite this fact the point of food security will become more sincere due to the forecasted global climatic changes in combination with the increasing world population.

Success of any plant breeding programme depends on the select of suitable genotypes as parents in the hybridization programme Salgotra *et al*., (2009). The combining ability parameter of parents and their crosses supply information on the components of variance *viz*., additive and dominance variance, which are significant to decide upon the parents and crosses to be selected for eventual success and also the appropriate breeding system.

The awareness of combining ability is effective to estimate nicking ability in self-pollinated crops and awareness into nature and relative magnitude of gene actions involved. It gives to the breeders an insight into nature and relative magnitude of fixable and non-fixable genetic variances Pradhan *et al*., (2006). Subsequently, our study was carried to get an idea and more facts of the combining ability for qualitative and quantitative traits with a view to identify good combiners which may be used to create a population with favourable genes for yield and yield component traits in rice.

So, the aims of this search were to detect the variation between rice genotypes and available crosses as well as general and specific combining abilities and their interaction. In addition to, assessment of different genetic parameters as additive, dominance, heritability and cluster analysis between the studied rice genotypes**.**

MATERIALS AND METHODS

This study was carried out at Department of Rice Research, Sakha, Kafr El-Sheikh, Egypt throughout the two successive rice growing seasons 2019 and 2020. Three rice genotypes namely; Giza178, GZ9399-4-1-1-3-2-2 and Sakha106 were used as female lines and crossed through line x tester mating design with four testers; Dular, GZ10101-5-1-1-1, Egyptian Yasmin and N22 to produce 12 F_1 hybrids during 2019 growing season. These genotypes have wide range of their characters due to their different genetic background and the origin, parentage and type of the parental lines are presented in Table 1.

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Table 1. Characterization of parental lines through origin, pedigree and type.

No.	Parents	Origin	Pedigree	Type
1	Giza178	Egypt	Giza175/ Milyang 49	Indica/ Japonica
2	GZ9399-4-1-1-3-2-2	Egypt	Giza 178 x IR65844-29-1-3-1-2	Indica /Japonica
3	Sakha106	Egypt	Giza 177 /Hexi 30	Japonica
4	Dular	India	Unknown	Indica
5	GZ10101-5-1-1-1	Egypt	Sakha 103 X IRI 385	Japonica
6	Egyptian Yasmin	Egypt	IR262-43-8-11 x KDML 105	Indica
7	N22	India	Selected from Rajbhog 1978	Indica

The seven parental lines in this investigation were sown during 2019 summer season in three sowing times, at 15 days intervals to overcome the difference of days to heading among the parental varieties. 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 after 30 days from sowing. Design for line x tester mating was conducted among the seven parents in 2019 growing season to harvest 12 F_1 crosses. The hybridization approach of Jodon, (1938) and modified by Butany, (1961). The resultant 12 F_1 hybrids along with their seven parents were evaluated in a randomized complete block design (RCBD) with three replications during 2020 growing season. All cultural practices such as fertilization, irrigation, weeds and pests' control were done as recommended with rice crop during growing seasons of the investigation. Data were collected on days to 50% heading (day), plant height (cm), flag leaf area (cm^2), number of panicles/plants, panicle length (cm), number of filled grains/panicle, sterility (%), 1000-grain weight (g) and grain yield (g/plant), according to the standard evaluation system for rice IRRI, (2004). The obtained data were subjected to line x tester analysis to assess general and specific combining ability effects and variances according to Kempthorne (1957). Heritability was predicted as stated by Borton and Devan (1953). The genetic distance tree system was expressed by using the Paleontological Statistics (PAST) software package using the mean performance of the studied genotypes Hammer *et al*., (2001). Predicted correlation coefficient was worked out using SPSS software (version 20.0).

RESULTS AND DISCUSSION

Mean performance of parental lines and their progeny

The mean performances of all rice genotypes in respect of studied traits are briefly presented in Table 2. The obtained results indicate that, the mean performances of the agronomic traits vary significantly between the tested genotypes. The earlier line GZ9399 was a female parental line in heading (89.67 days) but the early tester line was GZ10101 (91.0 days). obtained the lowest mean value for the combination GZ9399 x GZ10101 followed by Sakha106 x GZ10101with values 89 and 90 days, respectively. The lowest mean performance values were obtained for lines, testers and hybrid combinations exhibited the lowest plants for GZ9399, GZ10101and Sakha106 x GZ10101 with values of 101, 99 and 94 cm, respectively. For flag leaf area the results showed that, the promising line GZ9399, Egyptian Yasmin and hybrid combination Giza178 x Egyptian Yasmin gave the best leaf area with values of 33.17, 48.0 and 36.33, respectively.

Table 2. Mean performance of the lines, testers and their hybrid combinations for all studied traits.

Cat.	Genotypes	Days to 50% heading	Plant height (cm)	Flag leaf area (cm^2)	No. of panicles/ plant	Panicle length (cm)	No. of filled grains/ panicle	Sterility %	1000-Grain weight (g)	Grain yield/plant (g)
Lines	Giza178	103.00	106.00	28.55	24.00	25.00	163.67	7.68	21.17	46.53
	GZ9399	89.67	101.00	33.17	23.00	24.33	148.67	8.37	26.50	48.83
	Sakha 106	94.67	104.00	26.73	18.33	21.00	117.33	6.03	27.07	43.33
Testers	Dular	102.67	136.00	31.72	22.33	23.00	91.00	10.80	23.00	37.20
	GZ10101	91.00	99.00	22.90	19.00	22.90	143.67	5.83	27.30	45.44
	E. Yasmine	114.00	116.00	48.00	25.00	26.00	149.33	10.57	27.23	37.93
	N22	99.67	135.00	41.80	22.67	19.00	98.00	8.67	22.23	38.13
Hybrid combinations	Giza178 x Dular	102.33	128.00	31.20	24.67	24.00	158.00	11.77	25.67	52.07
	Giza178 x GZ10101	98.67	124.00	24.87	22.00	22.50	114.67	35.57	29.27	34.53
	Giza178 x E.Y	103.67	119.00	36.33	24.67	26.50	154.33	9.00	24.30	47.13
	Giza 178 x N22	105.33	139.33	35.30	22.00	20.67	160.33	5.77	25.77	50.17
	GZ9399 x Dular	99.67	127.33	33.43	26.00	25.00	160.67	9.70	27.30	54.13
	GZ9399 x GZ10101	89.00	115.33	25.83	24.00	26.00	120.33	35.90	28.70	37.30
	GZ9399 x E.Y	101.33	132.67	34.27	21.00	25.83	146.33	8.43	24.53	54.77
	GZ9399 x N22	90.67	106.33	34.17	31.67	23.00	151.67	9.93	24.53	52.73
	Sakha 106 x Dular	98.67	141.33	34.19	23.67	22.00	119.00	46.80	28.97	35.61
	Sakha106 x GZ10101	90.00	94.00	28.83	21.00	22.50	159.33	6.30	27.00	52.40
	Sakha 106 x E.Y	106.00	125.33	34.27	21.67	23.67	106.67	47.50	28.40	32.05
	Sakha106 x N22	93.67	98.67	34.90	19.00	22.00	110.33	42.37	26.30	35.47
	Grand mean	98.61	118.33	32.65	22.93	23.41	135.43	17.12	26.06	43.98
	Range	89-114	94-141.3	22.9-48	18.33-31.6	19-26.5	91-163.6	5.77-47.5	21.17-29.27	32.05-54.77
	S.E.	1.55	3.50	1.35	0.68	0.46	5.51	3.51	0.52	1.75

Also, number of panicles/plant there is different between lines, testers and hybrid combinations for this trait, the results recorded highly significant differences between hybrid combinations. The cross GZ9399 x Dular gave high value but hybrid combination Sakha106 x N22 gave the lowest value with (26 and 19 panicles) respectively. Among lines, the rice cultivar Giza178 showed the highest value (24 panicles) but Sakha106 as a tester gave the lowest number of panicles with value of 18.33. Also, for yield components traits the mean performances of the three female parent (lines) and four testers as male parents, as well as their F_1 hybrid combinations (panicle length (cm), number of filled grains/panicle, sterility %, 1000-grain weight and grain yield/plant) are listed in table 2. Related to panicle length the highest mean values between all the parental lines were observed for Giza 178 and Egyptian Yasmin (26 cm). Moreover the tallest panicles were detected in the hybrid combinations Giza178 x Egyptian Yasmin (26.5cm) and GZ9399 x GZ10101 (26 cm).

With regard to the number of filled grains/panicle data showed that Giza178 followed by Egyptian Yasmin and hybrid combination GZ9399 x Dular gave the height number of seeds in panicle (163.7, 149.3 and 160.7, respectively). The mean values of the sterility % revealed that, among parental lines the lowest value were record in Sakha 106 and GZ10101 with percentage 6.03 % and 5.83 %, respectively but Dular and Egyptian Yasmin gave the high percent of sterility %, whereas the F_1 mean values for the best combinations were Giza178 x N22 and Sakha 106 x GZ10101 compared with the other hybrid combinations. With regard to the 1000-grain weight, the results obtained indicated that the parental lines Sakha 106, GZ10101 and Egyptian Yasmin had the heaviest grains with the means of 27.07, 27.30 and 27.23g, respectively. The hybrid combinations, Giza178 x GZ10101, Sakha106 x Dular, GZ9399 x GZ10101 and Sakha 106 x Egyptian Yasmin displayed the heaviest grains with the means of 29.27, 28.97, 28.70 and 28.40 g, respectively. Highly significant differences were observed in the grain yield/plant traits analyzed (Table 2). As a female line GZ9399 showed the highest mean values (48.83 g), while the male parent as a tester GZ10101 observed the highest mean value (45.44 g) for grain yield/plant. The extreme eligible mean values were recorded for the hybrid rice combinations GZ9399 x Egyptian Yasmin (54.77g) and GZ9399 x Dular (54.13g).

Analysis of variance:

The collected data on agronomic parameters were subjected to analysis of variance to emphasize the differences among rice genotypes. Mean squares from analysis of variances of nine traits of rice are listed in Table 3. The results showed highly significant differences among rice genotypes for all the analyzed traits. For all traits highly significant differences were observed among the testers. Highly significant were detected for the interaction of line x tester for all traits. These results revealed that, there was a significant variation among lines, testers and hybrids; therefore, it is possible that to compute the general and specific combining abilities in the population parent and hybrids, respectively. The lines used in the research exhibited a variation with all traits exclude flag leaf area and 1000 grain weight. Also the testers showed significant differences for all traits. The interaction between lines and testers were stated as significant for all traits. The variance due to parent's *vs* crosses was also significant for all the characters indicating presence of hybrid vigor for these characters. The results were in agreement with the findings that have been described previously Abd El-Hadi *et al.*, (2013a) and Anis *et al.*, (2016).

The general (σ^2GCA) and specific combining ability values (σ^2SCA) variances showed that the σ^2GCA variance was less than the value of σ^2SCA variance for all traits except flag leaf area. Moreover, the σ^2GCA/σ^2SCA ratio was less than unity for all analyzed traits, except the same trait. These results revealed that the non-additive gene effects played a major role in the genetic expression of these traits, while the inheritance of the excepted trait (flag leaf area) was chiefly controlled by additive gene effects (Table 3). These results are in general agreement with those previously reported by Anis *et al.*, (2016) and Thirumalai *et al.*, (2018).

Table 3. Analysis of variance and mean square from mating design analysis all the studied traits.

S.O.V	D.F	Days to 50% heading	Plant height (cm)	Flag leaf area (cm^2)	No. of panicles/ plant	Panicle length (cm)	No. of filled grains/ panicle	Sterility %	1000-Grain weight (g)	Grain yield/plant (g)
Replications	2	2.22	2.33	2.20	0.23	1.25	34.75	2.88	1.13	11.11
Genotypes	18	138.16**	698.41**	104.54**	27.02**	12.36**	1733.33**	704.52**	15.62**	174.78**
Parents	6	212.19**	743.43**	232.35**	18.49**	17.39**	2373.74**	11.56**	21.56**	66.86**
P.*Vs*.C	1	12.95**	666.21**	12.41**	25.87**	4.86*	899.25**	2652.15**	42.93**	74.90**
Crosses	11	109.16**	676.78**	43.21**	31.78**	10.30**	1459.84**	905.73**	9.90**	242.72**
Lines	2	173.58**	490.19**	5.10*	56.44**	17.96**	1941.69**	1597.98**	7.93*	364.45**
Testers	3	205.58**	852.62**	141.52**	13.85**	17.80**	350.91**	67.11**	15.83**	58.00**
Line x testers	6	39.47**	651.05**	6.76**	32.52**	3.99**	1853.69**	1093.74**	7.59**	294.51**
Error	36	2.56	6.24	8.61	3.14	1.00	102.68	7.83	0.81	12.43
σ^2 GCA	---	1.93	2.85	1.10	0.20	0.17	22.51	11.92	0.03	3.24
σ^2 SCA	---	12.30	214.94	0.62	9.79	0.99	583.67	361.97	2.26	94.03
σ^2 GCA/ σ^2 SCA	---	0.16	0.01	1.76	0.02	0.17	0.04	0.03	0.01	0.03

***, ** Significant and highly significant at 0.05 and 0.01 levels of probability, respectively.**

General combining ability effects (GCA):

For illustrating genetic worth of parents for hybridization program, the general combining ability effects of 7 parents (3 line & 4 testers) for nine characters are consolidated in table 4. The results showed that GZ9399 and Sakha106 were the best combiners for early heading with highly significant and negative estimates of GCA effects. Conversely, Giza178 showed positive estimates of GCA and highly significant. Amongst the male lines (testers) GZ10101 and N22 showed negative values with highly significant for the same trait. These lines demonstrate to be useful combiners for early maturing, and can use for breeding earliness rice varieties.

For plant height negative GCA effects and minimum plant height are needed to protect the crop from lodging. As well as significant and negative GCA estimates for plant height, Sakha 106 gave the best results for plant height between the lines but in the testers GZ10101 and N22 showed high negative value. In case of other characters GCA positive effects are acceptable. Concerning flag leaf area, Egyptian Yasmin and N22 recorded the best results of GCA effects with significant values. The female line GZ9399 showed best general combiner for number of panicles/plants, also Dular as a tester gave good results for the same trait. These results conform to Singh and Kumar, (2004) and Alam *et al.*, (2004). The line GZ9399 and tester Egyptian Yasmin seem to be good combiners with new combinations for panicle length, while Sakha106 and N22 showed the low combiners with significant and negative GCA effects estimates. According to number of filled grains/panicle, Giza178 and GZ9399 as female parents showed significant GCA estimates, whereas Dular as a tester displayed significant and positive value. These results similarly with those obtained by Swamy *et al*., (2003); Alam *et al*., (2004) and Thirumalai *et al.*, (2018).

For sterility % trait negative GCA effects are desirable, the results indicated that Giza178 and GZ9399 were the best combiners for negative sterility percentage with highly significant and negative of GCA effects estimates. Conversely, Sakha 106 showed highly significant and positive of GCA estimates. While, the tester line N22 gave highly significant and negative value for sterility percentage. These lines proved to be good combiners for fertility, and could be used for breeding high seed set percentage rice cultivars. Swamy *et al*., (2003) selected two good combiners to decrease sterility and used as a good combiner for fertility. According to1000 grain weight, the line Sakha 106 showed highly significant and positive values for 1000-grain weight GCA estimates, as well as GZ10101 for the testers. For Grain yield/plant, GZ9399 exhibited highly significant and positive GCA values, thus proving to be a good parental combiner for grain yield/plant. On the other hand, Sakha106 and GZ10101 as parental lines showed significant and highly significant negative estimates of GCA. The positive values of the GCA mean increased for the grain yield/plant values, which could be useful in programs for breeding potentially high-yielding rice cultivars Thirumalai *et al*., (2018) and Zewdu, (2020).

Table 4. General combining ability effects for parents and their F_1 hybrid all the studied traits.

Cat.	Genotypes	Days to 50% heading	Plant height (cm)	Flag leaf area (cm^2)	No. of panicles /plant	Panicle Length (cm)	No. of filled grains/panicle	Sterility %	1000-Grain weight (g)	Grain yield/plant (g)
Lines	Giza178	4.25**	6.64**	-0.37	-0.11	-0.22	8.36**	-6.89**	-0.48*	1.11
	GZ9399	-3.08**	-0.53	-0.37	2.22**	1.32**	6.28*	-6.43**	-0.46*	4.87**
	Sakha 106	-1.17**	-6.11**	0.75	-2.11**	-1.10**	-14.64**	13.32**	0.94**	-5.98**
LSD 0.05%		0.78	1.21	1.43	0.86	0.48	4.92	1.36	0.43	1.71
0.01%		1.12	1.75	2.05	1.23	0.70	7.10	1.95	0.62	2.46
Testers	Dular	1.97**	11.27**	0.64	1.33*	0.03	7.42*	0.34	0.58	2.40
	GZ10101	-5.69**	-9.83**	-5.78**	-1.11	0.03	-7.02*	3.50**	1.59**	-3.45*
	E. Yasmin	5.42**	4.72**	2.65*	-1.00	1.69**	-2.69	-0.77	-0.98**	-0.21
	N22	-1.69**	-6.16**	2.49*	0.78	-1.75**	2.30	-3.06**	-1.19**	1.25
LSD 0.05%		1.10	1.72	2.02	1.22	0.68	6.96	1.92	0.62	2.42
0.01%		1.58	2.47	2.90	1.75	0.99	10.02	2.76	0.88	3.48

***and**, significant and highly significant, respectively.**

Specific combining ability effects (SCA):

Effects of SCA estimates for each F_1 hybrid combination for studied traits listed in Table 5. Relative to days to 50% heading, out of 12 hybrid combinations four crosses were found significant and highly significant negative SCA effects.

Table 5. Estimates of specific combining ability (SCA) effects for all studied traits

Hybrid combinations	Days to 50% heading	Plant Height (cm)	Flag leaf area (cm^2)	No. of panicles/ plant	Panicle length (cm)	No. of filled grains/ panicle	Sterility %	1000-Grain weight (g)	Grain yield/plant (g)
Giza178 x Dular	-2.14*	-10.86**	-1.36	0.00	0.55	3.75	-4.09**	-1.16*	3.68*
Giza178 x GZ10101	1.86*	6.25**	-1.26	-0.22	-0.94	-25.13**	16.53**	1.42**	-7.98**
Giza178 x E.Y	-4.25**	-13.30**	1.75	2.33*	1.38*	10.19*	-5.75**	-0.96*	1.37
Giza 178 x N22	4.52**	17.91**	0.88	-2.11*	-1.00*	11.19*	-6.69**	0.71	2.93
GZ9399 x Dular	2.52**	-4.36**	0.86	-1.00	0.01	8.50	-6.62**	0.45	1.99
GZ9399 x GZ10101	-0.47	4.75**	-0.30	-0.55	1.01*	-17.38**	16.40**	0.83	-8.98**
GZ9399 x E.Y	0.75	7.52**	-0.31	-3.66**	-0.81	4.27	-6.78**	-0.75	5.24**
GZ9399 x N22	-2.80**	-7.91**	-0.24	5.22**	-0.20	4.61	-2.99*	-0.53	1.74
Sakha 106 x Dular	-0.39	15.22**	0.50	1.00	-0.56	-12.25*	10.72**	0.71	-5.68**
Sakha106 x GZ10101	-1.39	-11.00**	1.57	0.78	-0.07	42.52**	-32.94**	-2.26**	16.97**
Sakha 106 x E.Y	3.50**	5.77**	-1.43	1.33	-0.56	-14.47**	12.53**	1.71**	-6.61**
Sakha106 x N22	-1.72*	-10.00**	-0.63	-3.11**	1.20*	-15.80**	9.68**	-0.17	-4.67*
LSD 0.05%	1.55	2.42	2.85	1.72	0.97	9.85	2.72	0.87	3.42
0.01%	2.24	3.49	4.10	2.47	1.40	14.17	3.91	1.25	4.93

***and**, significant and highly significant, respectively.**

The useful negatively significant values of SCA effects are desirable in Giza178 x Dular, Giza178 x Egyptian Yasmin, GZ9399 x N22 and Sakha106 x N22. With regard to plant height, data showed that the hybrid combinations Giza178 x Dular, Giza178 x Egyptian Yasmin, GZ9399 x Dular, GZ9399 x N22, Sakha106 x GZ10101 and Sakha 106 x N22 gave the best negative estimates SCA values. On the other hand, flag leaf area data exhibited non-significant for all hybrid combinations. According to number of panicles/plant, the data showed that just only two hybrid combinations (Giza178 x Egyptian Yasmin and GZ9399 x N22) gave good SCA effects with significant and high significant positive values. These studies are in conformity with the reports of Sarker *et al*., (2002) and Thirumalai *et al*., (2018).

Increased panicle length is desirable trait of rice variety with increased yield/plant. The cross combination namely, Giza178 x Egyptian Yasmin, GZ9399 x GZ10101 and Sakha 106 x N22 possess SCA significant and positive effects for panicle length. Giza178 x Egyptian yasmin, Giza178 x N22 and Sakha106 x GZ10101 showed SCA effects significant and highly significant positive for number of filled grains/panicle. For sterility percentage trait, the useful negatively significant values of SCA effects are desirable in Giza178 x Dular, Giza178 x Egyptian Yasmin, Giza178 x N22, GZ9399 x Dular, and GZ9399 x Egyptian Yasmin, GZ9399 x N22 and Sakha106 x GZ10101. On the other hand, Giza178 x GZ10101 and Sakha106 x Egyptian Yasmin recorded exhibited positive and significant SCA effects for 1000-Grain weight. Relative to the grain yield/plant value, three cross combinations Giza178 x Dular, GZ9399 x Egyptian Yasmin and Sakha106 x GZ10101 were significant and highly significant positive SCA estimates Thirumalai *et al*., (2018) and Zewdu, (2020).

Estimation of genetic parameters

Genetic variance components (σ^2A and σ^2D), heritability and contribution of the lines, testers and line × tester are listed in Table 6. The results showed that the dominance genetic variance (σ^2D) was greater than the additive genetic variance (σ^2A) in controlled the inheritance of all the studied traits, except flag leaf area which was governed by the additive genetic variance. These results are in general agreement with those previously reported by Abd El-Hadi *et al.*, (2013a); Anis *et al*., (2016) and Thirumalai *et al*., (2018).

Concerning the heritability estimates in broad sense, the results indicated that the heritability values are high for plant height (97.10%) and sterility % (97.73%), indicating slight effects of environment on the traits, (Pradhan *et al*., 2006 and Saleem *et al*., 2010). On the other hand, estimates of heritability in the narrow sense are low to moderate, these results also illustrated that main part of the total genotypic variance was non-additive in nature for these traits. Similar results were obtained by Mazal, (2014) and Sedeek, (2016)

On the contrary, the contributions of the lines were higher than the contribution of the testers for number of panicles/plant (32.30%), number of filled grains/panicle (24.18%), sterility % (32.10%) and grain yield/plant (27.30%). The contribution of line × tester interaction was important for number of filled grains/panicle (69.26%), grain yield/plant (66.18%), sterility % (65.88%), number of panicles/plant (55.81%) and plant height (52.47%). These results are in agreement with those obtained by Abd El-Hadi *et al*, (2013a) and Thirumalai *et al*., (2018).

Table 6. Estimates of genetic parameters for all the studied traits.

Genetic Parameter	Days to 50% heading	Plant height (cm)	Flag leaf area (cm^2)	No. of panicles/ plant	Panicle length (cm)	No. of filled grains/ panicle	Sterility %	1000-Grain weight (g)	Grain yield/plant (g)
Additive variance (σ^2 A)	3.85	5.70	2.17	0.41	0.34	45.02	23.84	0.06	6.48
Dominant variance (σ^2 D)	12.30	214.93	0.62	9.79	0.99	583.67	361.97	2.26	94.02
Broad sense heritability (h^2b) %	86.31	97.10	51.27	74.95	57.19	83.98	97.73	74.22	87.56
Narrow sense heritability (h^2n) %	20.57	2.64	21.33	3.27	14.66	7.02	6.89	1.82	6.49
Contribution of lines	28.91	13.17	2.13	32.30	31.71	24.18	32.10	14.57	27.30
Contribution of testers	51.36	34.36	89.33	11.89	47.14	6.56	2.02	43.60	6.52
Contribution of line x tester	19.72	52.47	8.54	55.81	21.15	69.26	65.88	41.83	66.18

Phenotypic correlation coefficient between the traits

In this study phenotypic correlation coefficient between the studied traits was done and the results are listed in table 7. Analysis correlation of agro-morphological, yield and its components traits showed that all the traits analyzed had a positive correlation with grain yield, except for days to 50% heading, plant height and sterility %. The strongest positive correlation coefficients were revealed between number of filled grains/panicle and grain yield (r = 0.818**), indicating the importance of this trait as selection criterion in yield improvement programs. While, days to 50% flowering had significant positive phenotypic correlations with flag leaf area (r = 0.610**). Moderate positive correlation estimates were recorded among days to 50% heading and flag leaf area (r = 0.610*), flag leaf area and panicle length (r = 0.541*), panicle length and number of filled grins/panicle (r = 0.542*) and sterility % with 1000 grain weight (r = 0.569*).

Table 7. Phenotypic correlation coefficients among all the studied traits.

Traits	Days to 50% heading	Plant height (cm)	Flag leaf Area (cm^2)	No. of panicles/ plant	Panicle length (cm)	No. of filled grains/ panicle	Sterility %	1000-Grain weight (g)	Grain yield/plant (g)
Days to heading	1.00								
Plant height	0.575*	1.00							
Flag leaf area	0.610**	0.335	1.00						
panicles/plant	0.096	0.152	0.322	1.00					
Panicle length	0.195	-0.121	0.541*	0.335	1.00				
Filled grains/panicle	0.045	-0.260	0.416	0.365	0.542*	1.00			
Sterility %	-0.035	0.171	-0.076	-0.116	-0.040	-0.550*	1.00		
1000-Grain weight	-0.205	-0.070	0.249	-0.189	0.048	-0.111	0.569*	1.00	
Grain yield	-0.177	-0.159	0.524*	0.395	0.325	0.818**	-0.727**	0.304	1.00

***Significant at 0.05 level **Significant at 0.01 level.**

The positive correlations coefficients between grain yield and number of panicles and spikelet fertility % indicate that better exploration of these traits along with flowering and plant height could be used to develop desired rice varieties/lines. This was also in confirmation with the findings of Mustafa and Elsheikh (2007), Jayasudha and Sharma (2010), Anis *et al*. (2016) and Anis (2019) for yield and yield component traits. In the same context, significant and highly significant negative correlations coefficient as exhibited for sterility % with number of filled grains/panicle (r = - 0.550*) and sterility % with grain yield/plant (r = - 0.727**). Similar results were also reported by Oladosu *et al*., (2014) and Anis, (2019).

Phylogenetic analysis based on mean performance of traits

Based on the mean performances of nine agro-morphological traits Euclidean distance was employed among the parental lines and their crosses. The UPGMA dendrogram was constructed using these values as indicated in Figure 1. These nine traits were days to 50% heading , plant height , flag leaf area, number of panicles/plant, panicle length, number of filled grain, sterility %, 1000 grain weight and grain yield/plant. The generated dendrogram divided the seven varieties and their hybrids into two main clusters based on morphological traits especially plant height, number of filled grains/panicle, sterility % and grain yield/plant traits. Generally, the first cluster was composed of two genotypes and second cluster include five genotypes. The first cluster included eight rice genotypes Sakha106, Dular, N22, Giza178 x GZ10101, GZ9399 x GZ10101, Sakha106 x Dular, Sakha106 x Egyptian Yasmin and Sakha106 x N22, and these varieties and hybrid combinations were characterized by higher in plant height and sterility % and lower in grain yield/plant. The second cluster included the all rest genotypes where almost similar in the same traits. The second cluster was split into two sub-groups based on plant height and number of filled grains/panicle. The first sub-group * only rice variety Egyptian Yasmin and five hybrid combinations (Giza178 x Dular, GZ9399 x Dular, Giza178 x Egyptian Yasmin, GZ9399 x Egyptian Yasmin and Giza178x N22) and was characterized by late in maturing, higher in plant stature and higher in number of filled grains/panicle compared to the rest of genotypes. The second sub-group included Giza178, GZ 9399, GZ10101, GZ9399 x N22 and Sakha 106 x GZ10101 and almost similar in the studied traits. Similar results were reported in rice by Rajesh *et al.,* (2010); Abd El-Hadi *et al.,* (2013b); Anis *et al.,* (2017) and Anis, (2019).

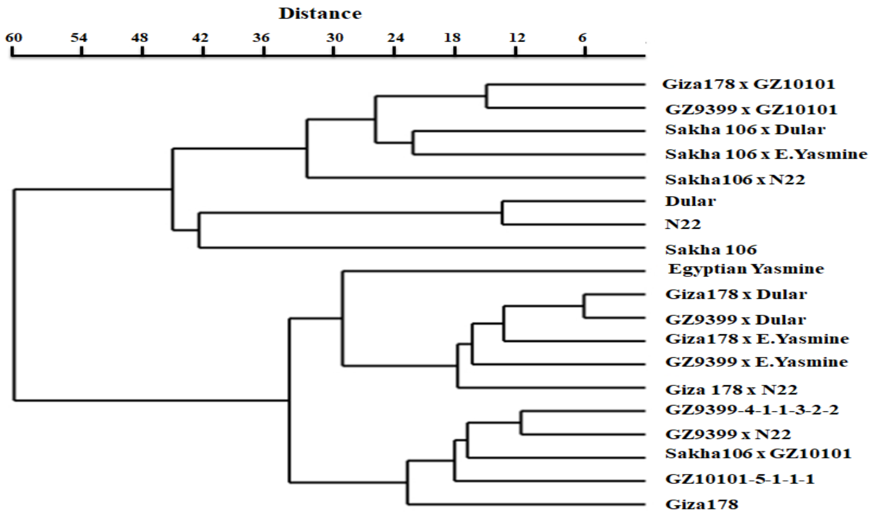

Figure 1. Dendrogram of seven parental lines and their hybrid combinations based on nine agro-morphological traits constructed by means of paired group and genetic distance.

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التحليل الوراثى لبعض الصفات النوعيه والكميه فى الأرز

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نجاح برنامج تربيه النبات يعتمد على اختيار التراكيب الوراثيه كآباء فى برنامج التهجين . لذا أجريت التجربة بالمزرعه البحثية بمحطة بحوث سخا – كفرالشيخ – مصر وذلك أثناء موسمى الزراعة 2019و 2020. وكان الهدف هو دراسة الاختلافات لبعض التراكيب الوراثية فى الأرز من خلال دراسة القدرة العامة والخاصة على التآلف وكذلك التفاعل بينهم بالاضافة الى تقدير المكونات الوراثية المختلفة بين الاصناف المستخدمة.تم التهجين بين ثلاث سلالات مع خمسة أصناف وذلك باستخدام نظام السلالة فى الكشاف حيث تم إنتاج 12 توليفة هجينية . وأظهرت النتائج أن التباين الراجع لكل من التراكيب الوراثية , الهجن , والآباء مقارنة بالهجن كان عالى المعنوية لجميع الصفات المدروسة. وكان تآثير القدرة العامة على التآلف أظهر أن الصنف سخا 106 كان أفضل الآباء المانحة لصفتي التزهير وطول النبات بينما كانت السلالة GZ9399 أفضل الآباء المانحة لصفات المحصول ومكوناتها وداخل الكشافات كانت السلالة GZ10101 أفضل الآباء المانحة لصفتي نسبة العقم ووزن الألف حبة . وبناء على دراسة ناثيرات القدرةالخاصة على التآلف كانت الهجن Giza178 x E.Yوالهجين Sakha106 x GZ10101 كانت أفضل التوليفات الهجينية لمعظم الصفات المدروسه . كان التباين الراجع للفعل الوراثى غير المضيف كان أكثر تحكما فى جميع الصفات المدروسة عن التباين الراجع للفعل الوراثي المضيف ماعدا صفة مساحة ورقه العلم . وأوضحت النتائج ان قيم درجه التوريث كانت عاليه لطول النبات ونسبه العقم مما يشير أن البيئة تلعب دور فى وراثة الصفات. وعلى العكس كانت درجه مساهمه السلالات أعلى من درجه مساهمه الكشافات فى صفه عدد السنابل وعدد الممتلئه ونسبه العقم ومحصول الحبوب. وقسمت الشجره الوراثيه السبع آباء وهجنها الى مجموعتين رئيسيتين بناءا على بعض الصفات المدروسه مثل طول النبات وعدد الحبوب المليانه ونسبه العقم. إن دراسه القدرة على التالف أكثر فاعلية فى تحديد أفضل الآباء وتوفير معلومات عن التفاعل الجيني الذى بدورة يساعد فى إنتخاب أفضل الآباء فى برنامج التربية.