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ESTIMATION OF GENERAL AND SPECIFIC COMBINING ABILITY FOR SOME VEGETATIVE, YIELD AND ITS COMPONENT TRAITS IN RICE *(Oryza sativa L.,)*

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ABSTRACT: *Twenty one genotypes, produced from diallel crossing without reciprocals of six parents were used to estimate the combining ability for vegetative, yield and its component traits. The experiment was carried out at the experimental Farm of the Rice Research and Training center (RRTC), Sakha, Kafr El -Sheikh during two successive rice seasons 2012 and 2013. Analysis of variance indicated that the genotypes were significantly different for all studied traits. The parent Sakha 103 was found to be a good combiner for earliness and short stature. The hybrid Sakha 101 x IET1444 gave desirable value of SCA effect for plant height, while Giza177 x Sakha 103 for days to heading. Sakha 101 x Sakha 104 has shown significant SCA effect for yield and its component traits.*

Key words: *Diallel analysis, Combining ability, additive and non-additive gene effects, and SCA effect*

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's most important food crop and energy source for about half of the world's populations and ranks second in population after maize (Manjappa and Shailaja, 2014). In Egypt, rice is considered the most popular and important field crop for several reasons: as a stable food after wheat for the Egyptian population, as exporting crop, as a land reclamation crop for improving the productivity of the saline soils widely spread in North delta and coastal area, and finally it is a social crop in which all farmers family member could gain money during its growing seasons. Rice species are Substantial but only *Oryza sativa* and *Oryza glaberrima*, which were originated from Southeast Asia and Niger basin in Africa, respectively, are cultivated. *Oryza sativa* is extensively cultivated due to its better adaption to local growing conditions and produces better yield. Genetic improvement for rice has been thoroughly been studied worldwide. Generally a rice breeding program will look into several objectives. Therefore, one way cross, top cross and back cross have extensively been used including diallel cross for study of genetic components, properties (Pooni et al., 1992 and Iftekharuddaula *et al.*, 2008). Diallel cross analysis helps to identify the best parents and their combinations for further selection and suggests the breeder the appropriate stage for selection as some traits are fully expressed after generations become uniform. Thus, the combining ability analysis, which is derived from a diallel mating design, is usually the appropriate method for choosing the parents and progenies with high general combining ability and high specific combining ability, respectively, the GCA and SCA can further determine the heritability (Falconer, 1989). In self-pollinated crops such as rice, the good of abrades is to develop true breeding homogeneous population with superior agronomic and other desirable

characteristics. Accomplishment of these objectives would depend on the suitable choice of the parental material, nature of gene action controlling characters under consideration and rational choice of breeding method for bringing a out quick and maximum genetic improvement. This would imply that basic knowledge of the genetic behavior of the characters under improvement is a pre-request for breeder to manipulate the breeding material in order to isolate superior lines (Hammoud, 1996). The objectives of the present investigation are: to study the inheritance of some vegetative traits, and yield and its components traits. To evaluate some breeding materials utilized in the local breeding program concerning combining ability effects (GCA and SCA effects).

MATERIALS AND METHODS

This experiment was carried out at the experimental Farm of the Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh during two successive rice seasons 2012 and 2013 to study the inheritance of some vegetative, yield and its components. Six rice entries namely; Giza 177, Giza 178, Sakha 101, Sakha 104, Sakha 103 and IET 1444 were chosen for this study. These entries have a wide range of variation due to their different genetic background. Planted during 2012in different sowing dates to get good synchronization of flowering to make the crosses among these entries to obtain hybrid seeds. The parents and their F1 crosses were sown in the nursery on the first week of May, seedlings were transplanted after 30 days. Bulk emasculation method was practiced by using hot water technique according to Jodon, (1938) and modified by Butany, (1961). a spacing of 20 cm x 20 cm. The experimental plots were grown in a randomized complete block design (RCBD), with three replicates; each replicate consisted of three rows for each F_1 with their parents. Each row was 5 meters long and contained 25 individual plants. The data were recorded on an individual plant basis for parents and $F1^s$ plants. The following characters were measured of parents, and F_1^s, for days to heading, plant height, number of productive tillers/plant, 1000-grain weight, total plant weight, grain yield/plant. All recommended agricultural practices were applied as usual for the ordinary rice field RRTC 2011. Weeds were chemically controlled. The statistical analysis was done using method 2, Model 1 of Griffing 1956 which is fixed model and was considered most appropriate as its all requirements were met by the experiment.

RESULTS AND DISCUSSION

Vegetative characters:

Mean performance:

Mean performance of vegetative characters for parents and their F_1 crosses are presented in Table (1). The average mean value of the parents was 98.6 days and the f1 crosses was 101.6 days , while, the general mean value was 100.8 days for days to heading, for plant height, the average mean value of the parents was 100.88 cm, and the f1 crosses was 103.3 cm, but the general mean value was 102.56 cm. Regarding the results of No of days to heading and plant height suggested that dominant effect was variable and depends on the genetic constitutions. Some crosses were tended to be toward the earliness and shorter stature, while others were found to be the lateness or taller stature. However, the means of the other crosses were intermediate between the their parents, indicating presence of partial or no dominance effect. The desirable mean values towards the earliness and shortness were obtained from parents, except the cross (sakh101x IET1444) wear the shortest and gave the lowest values.

Table (1): Mean performance of the six parents and their (F_1) crosses for vegetative characters during 2013 season.

Parents and crosses	Days to heading (day)	Plant height (cm)
Giza 177	91.33	103.33
Giza 178	101.33	104.33
Sakha 101	111.00	96.00
Sakha 104	105.33	111.33
Sakha 103	89.00	98.00
IET 1444	93.66	92.33
$\bar{x}$	98.6	100.88
Giza 177 x Giza 178	98.33	107.33
Giza 177 x Sakha 101	113.33	98.33
Giza177 x Sakha 104	111.33	115.00
Giza 177 x Sakha 103	84.66	98.66
Giza 177 x IET 1444	98.66	95.00
Giza 178 x Sakha 101	114.66	107.66
Giza 178 x Sakha 104	109.33	102.66
Giza 178 x Sakha 103	97.33	118.33
Giza 178 x IET 1444	96.66	98.66
Sakha 101 x Sakha 104	116.33	115.00
Sakha 101 x Sakha 103	96.66	93.66
Sakha 101 x IET 1444	107.00	90.33
Sakha104 x Sakha 103	99.00	105.33
Sakha 104 x IET 1444	92.66	109.33
Sakha 103 x IET 1444	90.66	93.33
LSD 5% 1%	3.09 4.14	2.61 3.49
$\bar{X}$ of the crosses	101.6	103.3
General $\bar{x}$(parent , crosses)	100.8	102.56

Analysis of combining ability

The analysis of variance revealed significant differences among the genotypes (parents and their crosses) for the two characters these results indicated the genotypic differences among in entries were present. Parents vs. Crosses mean square indicated that, average heterosis over all crosses and therefore could be used through hybrid breeding technology to improve such traits. Estimates of both general (GCA) and specific combining ability (SCA) variances for vegetative characters are presented in Table (2). Both general and specific combining ability variance were found to be highly significant for all

vegetative characters, indicating the importance of additive and non-additive genetic variance in determined using GCA and SCA ratio. The GCA/SCA variance was found to be higher than unity for days to heading, suggesting greater importance of additive genetic variance in the inheritance of these character. In constant, GCA /SCA ratio was found to be less than unity for plant height, indicator to the non additive genetic variance play important role in the inheritance characin the results in agreement with that reported by, Bhave *et al.* (2003), stated that the additive genetic variance is more important for inheritance of days to heading and plant height.

General combining ability (GCA) effects

Estimates of the general combining ability effects of the individual parent's lines for vegetative traits are given in Table (3). Highly significant and negative (GCA) values were recorded for no of days to heading and plant height which are desirable for improvement of these traits in breeding program since the low values are the target of breeder. Regarding No. of days to heading, the parents i.e.Giza 177. IET 1444 and Sakha 103 showed highly significant and negative general combining ability effects-2.13. -4.13 and -7.47, indicating that these entries could be considered as good combiners for the improvement of this trait (earliness). With respect to plant height, two entries viz, Sakha 101 and IET1444 exhibited highly significant and negative general combining ability with values -2.62 and -5.83 respectively.

Specific combining ability (SCA) effects

Estimates of specific combining ability effects are shown in Table (4). For No. of days to heading showed that (SCA) of five crosses were highly significant and negative, the SCA values were ranged between -1.67 for Giza 178 x IET 1444 to -8.22 for Sakha104 x IET 1444 the crosses which gave negative significant values could be utilized in rice breeding program to improve this trait. nine crosses exhibited highly significant and negative (SCA) effects for plant height which ranged between -2.69 for Giza 177 x Sakha 103 to -9.57 for Giza 178 x Sakha 104.

Table (2): Analysis 0f variance for vegetative characters of a six parents with their f1 crosses during 2013 season.

Source of variance	d.f	Days to heading (day)	Plant height (cm)
replications	2	2.20	8.19
Genotypes	20	255.98	199.33
parents	5	225.522	139.42
crosses	14	275.94	229.25
Parents vs. crosses	1	128.92	72.69
GCA	5	257.85	153.35
SCA	15	27.81	37.47
Error	40	1.17	0.83
GCA/SCA		1.2	0.52

*** donates significant at 0.01 level of probability and d.f = degrees of freedom*

Table (3): Estimates of general combining ability effects of a six-parents for vegetative characters during 2013 season.

Parents	Days to heading (day)	Plant height (cm)
Giza 177	-2.13 *	0.37 ns
Giza 178	1.61ns	3.16 **
Sakha 101	7.98 **	-2.62 **
Sakha 104	4.15 **	6.50 **
Sakha 103	-7.47 **	-1.58 ns
IET 1444	-4.13 **	-5.83 **
LSD 5%	**1.94**	**1.61**
1%	**2.59**	**2.16**

and denotes significant 0.05 and 0.01 level of probability. LSD means standard error*

Table (4): Estimates of specific combining ability effects of F_1 crosses for vegetative characters during 2013 season.

Parents	Days to heading (day)	Plant height (cm)
Giza 177 x Giza 178	-2.01**	1.22**
Giza 177 x Sakha 101	6.61**	-1.98**
Giza177 x Sakha 104	8.44**	5.55**
Giza 177 x Sakha 103	-6.59**	-2.69**
Giza 177 x IET 1444	4.07**	-2.11**
Giza 178 x Sakha 101	4.19**	4.55**
Giza 178 x Sakha 104	2.69**	-9.57**
Giza 178 x Sakha 103	2.32**	14.17**
Giza 178 x IET 1444	-1.67**	-1.23**
Sakha 101 x Sakha 104	3.32**	8.55**
Sakha 101 x Sakha 103	-4.72**	-4.69**
Sakha 101 x IET 1444	2.27**	-3.77**
Sakha104 x sakha103	1.44**	-2.15**
Sakha 104 XIET1444	-8.22**	6.09**
Sakha 103 x IET1444	1.40**	-1.82**
LSD 5%	**0.70**	**0.59**
1%	**0.94**	**0.79**

** and** denotes significant at 0.05 and 0.01 levels of probability.*

Yield and its components
Mean performance

The results in table (5) showed that the average mean value of the parents were 81.09,24.44,25.27 and 40349 for the plant weight, no. of productive tillers / plant , 1000-grain weight and grain yield/ plant respectively. While for the f1 crosses were 75.07,29.00,25.38 and 42.69, respectively. But the general average mean values were 76.79,27.7, 25.35 and 42.38, respectively, indicating that the hybrid vigour in F_1 crosses were found for all the studied traits expect plant weight. The crosses Giza 177x Giza 178, Giza 178 x Sakha 104 recorded the highest values of plant weight while, Sakha 103 x IET1444 and Sakha 104 x IET1444 showed the lowest values. Concerning to no of productive tillers/plant, Giza 178 x IET1444, Giza 178 x Sakha 101 and Giza 177x Giza 178 exhibited the highest values 36.00, 35.00 and 33.33 cm, respectively. While the crosses Giza 177x Sakha 103 and Sakha 101 x Sakha 103 gave the lowest values 23.66 and 24.00cm, respectively. For 1000- grain weight, data in Table (6) revealed that the crosses Giza 177x Sakha 101, Giza 178 x Sakha 101 and Giza 177x Sakha 104 recorded the highest values 32.06, 31.66 and 30.80, respectively. On the other hand the combination of Giza 178 x IET1444 gave the lowest value 20.36. Concerning to grain yield plant^{-1}, the crosses Giza 178 x Sakha101, Sakha 101 x Sakha104 and Giza 178 x Sakha 104 gave the highest values 49.32, 49.02 and 48.04 gram, respectively. While, the rice variety IET 1444 recorded the lowest value of grain yield plant^{-1}34.34gm under the same condition.

Analysis of variance

Table (6) showed that the analysis of variance for yield traits were highly significant and differences for the genotypes and parents with their crosses. Parents vs. Crosses mean square differences and highly significant for all studied traits except 1000-grain weight, indicating to average heterosis over all crosses were found and could be used these crosses in breeding of hybrid rice program. i.e. plant weight, no. of productive tillers/ plant , 1000- grains weight and grain yield plant^{-1}. Both general and specific combining ability variances were found to be highly significant for yield and its components traits. This indicates the importance of both additive and non-additive genetic variance in the inheritance of these traits. GCA/SCA ratio was found to be less than unity for plant weight and no .of productive tillers/plant, in constant, were found to be higher than unity for traits. The 100-grain weight and grain yield/ plant traits therefore, it could be concluded that selection procedures based on the accumulation of additive effect would be successful in improving these traits. The results obtained are in agreement with that reported by El-Refaee, (2002), El-Abd *et al.* (2003), El-Mawafi and Abou Shousha, (2003) and Vanaja *et al.* (2003).

General combining ability (GCA):

High positive values of GCA effects would be interest in plant weight, No. of productive tillers/ plant, 1000- grains weight and grain yield plant $^{-1}$ from the breeding point of view. Data in Table (7) revealed that the parent Giza 178 could be a good combiner for plant weight its exhibited highly significant and positive estimate of GCA effect. In case of No. of productive tillers/plant Giza178 and IET1444 showed highly significant and positive estimates of general combining effects. Concerning 1000-grains weight Giza 177 and Sakha 101 gave highly significant and positive GCA effects; consequently these entries could be used in breeding program as agood combiners to increase 1000- grains weight. For grain yield plant^{-1} Table (7) showed that

the entries Sakha 101, Giza 178 and Sakha 104 gave highly significant and positive values of GCA effects 4.32, 2.42 and 1.33 respectively indicating to could be used these entries in breeding program to improve the rice productivity.

Table (5): Mean performance of the parents and their F1 crosses for yield and its components traits during 2013 season.

Parents and crosses	plant weight (g)	No. of productive tillers/plant	1000-grains weight (g)	Grain yield/plant (g)
(P1) Giza 177	76.03	23.00	27.46	38.16
(P2) Giza 178	88.41	28.00	22.56	46.75
(P3) Sakha 101	83.74	24.66	29.50	46.27
(P4) Sakha 104	83.20	23.00	26.43	44.05
(P5) Giza 103	80.77	22.00	24.53	36.00
(P6) IET1444	74.38	26.00	21.13	34.34
x- of parents	**81.09**	**24.44**	**25.27**	**40.93**
Giza 177 x Giza 178	95.25	33.33	27.00	42.18
Giza 177 x Sakha 101	81.09	26.66	32.06	47.98
Giza177 x Sakha 104	72.76	25.00	30.80	43.28
Giza 177 x Sakha 103	69.76	23.66	25.60	36.70
Giza 177 x IET 1444	70.49	32.33	20.76	39.01
Giza 178 x Sakha 101	83.40	35.00	31.66	49.32
Giza 178 x Sakha 104	88.41	32.00	24.23	48.04
Giza 178 x Sakha 103	77.68	27.33	22.56	45.09
Giza 178 x IET 1444	72.41	36.00	20.36	37.91
Sakha 101x Sakha104	67.65	25.00	27.33	49.02
Sakha 101 x Sakha 103	69.84	24.00	25.90	46.89
Sakha 101 x IET 1444	81.41	30.66	23.16	45.55
Sakha104 x sakha103	68.94	26.33	23.66	41.46
Sakha 104 X IET1444	64.77	29.00	24.30	37.46
Sakha 103 x IET1444	62.15	28.66	21.26	34.50
LSD 5% **1%**	**3.57** **4.77**	**2.04** **2.73**	**0.92** **1.24**	**0.87** **1.17**
x- of crosses	**75.07**	**29.00**	**25.38**	**42.96**
General x- of(parent, crosses)	**76.79**	**27.7**	**25.35**	**42.38**

Table (6): Analysis of variance of a six parents with their F1 crosses for yield and its component traits during 2013 season.

Source of variance	d.f	Plant weight(g)	No. of productive tillers/plant	1000-grains weight(g)	Grain yield/plant(g)
Replication	2	6.45	1.25	0.85	0.27
Genotypes	20	222.50**	51.26**	37.65**	75.77**
Parents	5	81.42**	15.15**	29.42**	88.45**
Crosses	14	255.46**	48.76**	43.27**	77.56**
Parents vs. crosses	1	466.27**	266.82**	0.150ns	53.10**
GCA	5	140.56**	36.19**	36.55**	83.54**
SCA	15	52.03**	10.71**	4.54**	5.83**
Error	40	1.56	0.51	0.10	0.093
GCA/SCA		0.34	0.43	1.02	1.81

** and ** denote significant at 0.05 and 0.01 levels of probability, respectively. d.f =degrees of freedom*

Table (7): Estimates of general combining ability effects of the six parents for yield and its components traits during 2013 season.

Parents	Plant weight(g)	No of Productive tillers /plant	1000-grain weight(g)	Grain yield/plant(g)
Giza 177	0.48ns	-0.86ns	1.71**	-1.39**
Giza 178	7.05**	3.22**	-0.80**	2.42**
Sakha 101	1.66ns	-0.40ns	2.71**	4.32**
Sakha 104	-1.07ns	-1.31*	0.72*	1.33**
Sakha 103	-3.45**	-2.48**	-1.17**	-2.50**
IET 1444	-4.68**	1.84**	-3.16**	-4.19**
LSD 5%	**2.23**	**2.23**	**0.58**	**0.55**
1%	**2.99**	**2.99**	**0.78**	**0.73**

** and ** donates significant at 0.05 and 0.01 level of probability ,respectively. S.E means standard error and n.s means not significant*

Specific combining ability effects (SCA):

Estimates of the specific combining ability effects for the hybrid combinations for yield and its components are given in Table (8). The significant desirable interalelic interaction would only discuss here. In case of plant weight four crosses gave highly significant and positive estimates of SCA effects. The best crosses were Giza 177x Giza 178 and Giza 178x sakha 104 respectively. The cross which gave the

highest value of plant weight can used in breeding program to improve this trait. Data in Table (6) revealed nine crosses which recorded highly significant positive estimates of SCA effects for no. of productive tillers/plant. The best hybrid combinations which recorded the highest values were Giza 178 x IET1444, Giza 178x Sakha 101 and Giza 177 x giza 178 showed 36. 35 and 33. 3, respectively. six crosses exhibited highland significant positive estimates of SCA for 1000-grain weight. The hybrid combinations, Giza 177 x Sakha 101, Giza 178x Sakha 101 and Giza 177x Sakha 104 gave the highest values of SCA effects. These crosses could be used in breeding program for Increasing this trait. Concerning the grain yield plant^{-1}, three crosses exhibited highly significant and positive estimates of SCA effects. The Crosses which recorded the highest values were Sakha 101 x sakha 104, Giza 178 x Sakha 101 Giza 177 x Sakha 101, indicating that these crosses could be used in breeding programs to improve this trait.

Table (8): Specific combining ability effects of the f1 crosses for yield and its yield components during 2013 season.

Crosses	Plant weight(g)	No of productive tillers /plant	1000-grain weight(g)	Grain yield/plant (g)
Giza 177 x Giza 178	10.91**	3.27**	0.74**	-1.22**
Giza 177 x Sakha 101	2.14**	0.23ns	2.29**	2.67**
Giza 177 x Sakha 104	-3.43**	-0.51*	3.01**	0.96**
Giza 177 x Sakha 103	-4.06**	-0.68**	-0.29**	-1.78**
Giza 177 x IET 1444	-2.09**	3.64**	-3.13**	2.21**
Giza 178 x Sakha 101	-2.11**	4.48**	4.41**	0.18ns
Giza 178 x Sakha 104	5.63**	2.39**	-1.02**	1.89**
Giza 178 x Sakha 103	-2.71**	-1.10**	-0.80**	2.79**
Giza 178 x IET 1444	-6.74**	3.23**	-1.00**	-2.69**
Sakha 101x x Sakha 104	-9.73**	-0.97**	-1.44**	0.97**
Sakha 101 x Sakha 103	-5.16**	-0.80**	-0.98**	2.67**
Sakha 101 x iet 1444	7.64**	1.52**	-1.72**	3.03**
Sakha 104 x xSakha 103	-3.32**	2.44**	-1.22**	0.24*
Sakha 104 x IET 1444	-6.25**	0.77**	1.39**	-2.06**
Sakha 103 x IET 1444	-6.49**	1.60**	0.25*	-1.18**
LSD 5% 1%	0.81 1.09	0.46 0.62	0.21 0.28	0.20 0.26

** and ** indicate significant at 01.05 and 0.01 levels of probability, respectively. n.s means not significant.*

Conclusion

Diallel mating design for rice varieties served as the most important step in breeding programs. The derived information such as the parent's performance (Revealed by GCA) and interaction of parents (revealed by SCA) could be used by breeders. In both cases, parents with high GCA value and combinations with significant SCA value could be selected for further breeding approach. This study indicated that additive gene action was found important for most traits such as 1000-grain weight and grain yield/plant.

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تقدير القدرة العامة والخاصة علي الائتلاف لبعض الصفات الخضرية والمحصولية في الارز

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الملخص العربى

أجريت تجربة حقلية في مزرعة مركز البحوث والتدريب في الارز سخا كفر الشيخ خلال موسمي الدراسة ٢٠١٢و٢٠١٣م استخدم فيها ستة أصناف ارز مختلفة للحصول علي ١٥ هجين بنظام نصف دايالليل لدراسة تأثير القدرة العامة والخاصة للائتلاف للصفات الخضرية والمحصولية في الارز .

وتشير النتائج إلى أن تحليل التباين قد أظهر وجود اختلافات معنوية بين التراكيب الوراثية لكل الصفات المدروسة وكان الصنف سخا ١٠٣ افضل مانح للتبكير والساق القصيرة والهجين جيزة ١٧٧ × سخا ١٠٣ للتبكير والهجين سخا ١٠١× اي ايى تي ١٤٤٤ للساق القصيرة وأعطي الهجين سخا ١٠١× سخا ١٠٤ قدرة خاصة عالية للمحصول ومكوناته.