Electronic Journal of Plant Breeding, 9 (2) : 753 - 758 (June 2018) DOI: 10.5958/0975-928X.2018.00090.X
ISSN 0975-928X

Research Article

Combining ability study in rice (*Oryza sativa* L.)

S. Suvathipriya[1] And T. Kalaimagal [2]
[1]Anbil Dharmalingam Agricultural College and Research Institute, Navalur Kuttupattu, Trichirapalli-620009
[2]Centre for Plant Breeding and Genetics, TNAU, Coimbatore- 641003
E-mail: suvathipriyahari@gmail.com

(Received:03 Jul 2018; Revised: 6 Jul 2018; Accepted: 06 Jul 2018)

Abstract
In the present investigation combining ability study was undertaken by crossing five lines and four testers in Line x Tester fashion. Based on the *gca* effects, the five parents CO (R) 50, ADT 49, MDU 6, CSR 27 and Ezhome 1 were identified as the best combiners for yield and various yield attributing traits and two other qualitative traits. Regarding hybrids, ADT 49 / CSR 23, ADT 49 / CSR 27, CO (R) 50 / Anna 4 and CO (R) 50 / CSR 23, MDU 6 / Ezhome 1, ASD 16 / CSR 23 and CO (R) 50 / CSR 27 were identified as best specific combiners for yield and yield attributing traits. The study also reveals the preponderance of non-additive gene action which favors the commercial exploitation of these hybrids improve yield ultimately. The same hybrids would also produce promising and desirable segregants in the segregating generations.

Key words
Combining ability, *gca*, *sca*, TNAUSTAT, segregants,

Introduction

Rice is the most important staple food crop for more than 60% of the world's population especially confined to the people of Asian countries. Across countries i.e., globally the area under paddy cultivation is 161.1 million ha with an annual production of about 751.9 million tons FAO(2016). The worldwide production of milled rice accounts for 483.9 million metric tons Statista(2016). According to Directorate of Economics and Statistics (D & ES, 2016- 2017), India enjoys 44.2 million ha of area under rice cultivation with 104.32 million tons of rice production.

At present the major predicament across countries is the increasing population, which foists the compulsion for increased food production to meet the future food requirements for a majority of the population in the world. A survey by Food and Agricultural Organization FAO(2016) clearly depicts that 6.5% (831 million ha) of the world's total area (12.78 billion ha) is affected by salts in soils. This is due to many dynamics like climate change, sea water intrusion, improper drainage facilities, improper leaching of ions, high evaporation as a result of low precipitation, etc.,

In order to increase the rice production and productivity even under such stress affected areas it is indispensable to develop stress tolerant rice varieties. This is possible by means of exploiting hybridization program between high yielders and stress tolerant rice varieties. This present study on rice also embroils the analysis on Combining ability which is useful to elucidate the nature and magnitude of gene action entangled for trait of interest Kannan and Ganesh(2016).

Materials and Methods

The present experiment on rice was carried out from 2016 to 2017 in the farm of Anbil Dharmalingham Agricultural College and Research Instiitute, Trichy and from 2017 to 2018 at the south farm of Tamil Nadu Rice Research Institute, Aduthurai. The materials of the study comprises 9 parents i.e., 5 high yielding lines *viz.*, TKM 13, MDU 6, ASD 16, ADT 49 and CO (R) 50 and 4 sodic tolerant testers *viz.*, CSR 27, Anna 4, Ezhome 1 and CSR 23. The staggered sowing of the parents were taken to facilitate synchronization in flowering. The crossing was effected between the lines and testers in Line x Tester mating design Kempthorne(1957) to develop sodic tolerant hybrids. The good combiners among the parental genotypes and good hybrid combination from the crosses were ascertained using *gca* and *sca* effects Sprague and Tatum (1942).

The crossing technique adopted in this study involves two steps, clipping method of emasculation and dusting. Emasculation of the female spikelets is done before the commencement of anthesis. At the time of anthesis dusting of the pollen grains from the well ripened anthers of male parent is done. Then, the individual crossed panicle was labeled and covered with butter paper cover. At the time of physiological maturity stage the hybrid seeds were collected from 20 cross combinations. The selfed seeds were also collected from the parental lines.

The F_1 seeds from 20 cross combinations along with 9 parents were sown and planted in randomized block design with two replications in the south farm of Tamil Nadu Rice Research Institute, Aduthurai. The planting was done at a recommended spacing of 20 x 20 cm. Fertilizer and pesticide applications was done at required time interval. The biometrical observations like days to 50 per cent flowering, plant height, number of productive tillers per plant, panicle length, number of filled grains per panicle, spikelet fertility per cent, 1000 grain weight, single plant yield and days to maturity and two qualitative traits *viz.,* amylose content and protein content were recorded from the hybirds and parents and the mean performance were tabulated. The statistical analysis of the data was done using TNAUSTAT.

Results and Discussions

Analysis of variance of combining ability showed significant differences among the genotypes and the developed hybrids for all the traits taken for the study, except for spikelet fertility percentage, revealing the divergent nature of the parents (Table 1). Also the significant mean sum of squares for line x tester depicted the occurrence of additive variance for all the traits except for spikelet fertility percentage. This report was supported by the findings of Gopikannan and Ganesh (2013).

The general combining ability (*gca*) identifies superior parents while specific combining ability (*sca*) aids in identification of good hybrid combinations which may successfully lead to the development of hybrids. It was earlier suggested that parents with high *gca* would produce transgressive segregants in F_2 or later generations. Its role is important to decide parents, crosses and appropriate breeding procedure to be followed to select desirable segregants Salgotra *et al.(*2009).

Regarding, days to 50 % flowering, plant height and days to maturity, the negatively significant *gca* effects were considered desirable whereas positive *gca* effects were considered desirable for the remaining traits. In the present experimental study, desirably significant estimates of general combining ability of parents were showed for various traits by three lines *viz.,* CO (R) 50 for number of productive tillers plant, panicle length, number of filled grains per panicle, amylose content, protein content and single plant yield, ADT 49 for days to 50 per cent flowering, 1000 grain weight, days to maturity, single plant yield and amylose content and MDU 6 for days to 50 % flowering, plant height, 1000 grain weight, days to maturity and protein content (Table 2).

The similar desirably significant *gca* values were registered for various traits by two testers *viz.,* CSR 27 for panicle length, number of filled grains per panicle, 1000 grain weight, single plant yield and amylose content, Ezhome 1 for days to 50 % flowering, plant height and days to maturity. Hence, involving these good combiners in the process of developing hybrids were expected to render promising and desirable hybrids (Table 2).

The performance of a hybrid could be evaluated by its specific combining ability effects. The expediency of a particular cross in the exploitation of heterosis is judged by its specific combining effects Jayasudha *et al.(*1937*)*. The specific combing ability effects are due to non-additive and epistatic gene action Sprague and Tatum (1942).

Regarding evaluation of hybrids based on its *sca* effects, negatively significant *sca* effects were considered desirable for three traits *viz.,* days to 50 % flowering, plant height and days to maturity, whereas positively significant *sca* effects were considered desirable for all the other traits, similar to that of general combining ability effects.

The study revealed that the hybrids *viz.,* CO (R) 50 / CSR 23 for days for 50 % flowering, ADT 49 / CSR 23, ADT 49 / CSR 27, CO (R) 50 / Anna 4 and CO (R) 50 / CSR 23 showed desirable negatively significant *sca* effects. With respect to yield, three hybrids *viz.,* MDU 6 / Ezhome 1, ASD 16 / CSR 23 and CO (R) 50 / CSR 27 recorded high and significant *sca* effects and the parents of these hybrids were in combination of poor x good, poor x poor and good x good parents. This insists the non-additive gene action in their inheritance pattern. Hence, the selection is postponed to later generations (Table 3). This finding was in accordance with the finding of Saleem *et al.* (2010), Mirarab *et al.*(2011), Raju *et al.* (2014), Bhatti *et al.*(2015) and Madhuri *et al.* (2017).

Thus from the above results and discussions, it was concluded that exploiting of these parents and hybrids in recombinant breeding programme could throw promising segregants in segregating generations.

Reference

Bhatti, S., Pandey, D. P., and Singh, D. 2014. Gene action and combining ability studies in rice. *Oryza.,* **51** : 162–164.

Directorate of Economics & Statistics (D & ES).

FAO. (2016). Food and Agricultural Online Interactive Database on Agriculture. www.fao.org.

Gopikannan, M. and Ganesh, S. K. 2013. Investigation on combining ability and heterosis for sodicity tolerance in rice (*Oryza sativa* L.). *Afr. J. Agric. Res.,* **8** : 4326–4333.

Jayasudha, S. and Sharma, D. 1937. Combining Ability and Gene Action Analysis for Yield and its Components in Rice (*Oryza sativa* L .). *Journal of Rice Research.,* **2 :** 105–111.

Kannan, G. R. and Ganesh, S. K. 2016. Combining ability analysis for yield , its components and physiological traits in rice under sodicity. *Electronic Journal of Plant Breeding.,* **7** : 555–563.

Kempthorne, O. 1957. An introduction to genetic statistics, John Wiley and Sons, New York.

Madhuri, R., Shivakumar, N., Bindhu, K. G., Lohithaswa, H. . and Pavan, R. 2017. Gene action and combining ability estimates of newly developed CMS based heterotic rice hybrids (*Oryza sativa* L .). *Jourrnal of Applied and Natural Science.,* **9** : 1557–1565.

Mirarab, M., Ahmadikhah, A. and Pahlavani, M. H. 2011. Study on combining ability , heterosis and genetic parameters of yield traits in rice. *Afr. J. Biotechnol.,* **10** : 12512–12519.

Raju, C. D., Kumar, S. S., Raju, C. H. S. and Srijan, A. 2014. Combining ability Studies in the Selected Parents and Hybrids in Rice (*Oryza sativa*. L). *Int. J. Pure App. Biosci.,* **2** : 271-279

Saleem, M. Y., Mirza, J. I. and Haq, M. A. 2010. Combining ability analysis for yield and related traits in basmati rice (*Oryza sativa* L .), *Pak. J. Bot.,* **42** : 627–637.

Salgotra, R. K., Gupta, B. and Singh, P. 2009. Combining ability studies for yield and yield components in Basmati rice. *Oryza.*, **46** : 12–16.

Sprague, G. F. and Tatum, L. A. 1942. General vs specific combining ability in single crosses of corn. *J.American Soc. Agron.,* **34** : 923–932.

Statista. 2016. The Statistics Portal. 2016. World production volume of milled rice from 2008/2009 to 2015/2016 (Seasonally adjusted).

Electronic Journal of Plant Breeding, 9 (2) : 753 - 758 (June 2018) DOI: 10.5958/0975-928X.2018.00090.X
ISSN 0975-928X

Table 1. Analysis of Variance of combining ability for different quantitative and qualitative traits in rice

Source of Variations	df	DFF	PH (cm)	NPT	PL (cm)	NFG	SF%	TGW (g)	DM (days)	SPY (g)	AC	PC
Replications	1	1.23	0.89	0.10	2.40	24.03	2.08	0.03	0.10	21.61	0.07	0.0023
Hybrids	19	120.52**	333.60**	33.45**	7.29*	4257.75**	57.72	19.66**	227.64**	489.43**	2.11**	0.57**
Lines	4	109.38**	699.60**	48.46**	14.56**	10859.85**	77.08	55.36**	51.71**	1638.86**	7.82**	1.98**
Testers	3	540.09**	588.66**	6.13	4.55*	6444.36**	58.05	14.45**	1222.30**	515.72**	0.51**	0.076**
Lines x Testers	12	19.34**	147.83**	35.28**	5.55**	1510.40**	51.19	9.07**	37.61**	99.71**	0.61**	0.22**
Error	19	0.60	0.40	2.31	0.96	288.66	36.05	0.67	0.63	8.75	0.04	0.0007

* Significant at 5 per cent level
** Significant at 1 per cent level

DFF – Days to 50% flowering, **PH** – Plant Height, **NPT** – Number of productive tillers per plant, **PL** – Panicle Length, **NFG** – Number of filled grains per panicle, **SFP** – Spikelet fertility percentage, **TGW** – Thousand grain weight, **DM** – Days to Maturity, **SPY** – Single Plant Yield, **AC** – Amylose content, **PC** – Protein content

Table 2. General combining ability effects of parents for different quantitative and qualitative traits in rice

Parents		DFF	PH (cm)	NPT	PL (cm)	NFG	SF (%)	TGW	DM	SPY	AC (%)	PC (%)
Lines												
TKM 13	L_1	0.13	-7.12**	-1.10	-0.08	22.67**	2.95	-4.58**	0.10	-7.34**	-0.52**	-0.82**
MDU 6	L_2	-3.88**	-3.64**	-3.22**	-1.49**	-51.95**	-3.27	1.32**	-2.40**	-12.11**	-1.23**	0.30**
ASD 16	L_3	-0.38	-6.65**	-0.10	-0.43	-17.83**	3.63	1.51**	-0.52	-8.55**	-0.22**	0.37**
ADT 49	L_4	-1.88**	1.99*	1.02	-0.20	3.67	-2.17	1.62**	-1.40**	5.22**	0.73**	-0.12**
CO (R) 50	L_5	6.00**	15.42**	3.40**	2.20**	43.42**	-1.13	0.13	4.22**	22.77**	1.24**	0.27**
SE		**0.27**	**0.22**	**0.54**	**0.35**	**6.01**	**2.12**	**0.29**	**0.28**	**1.05**	**0.07**	**0.01**
Testers												
CSR 27	T_1	3.72**	9.06**	-0.80	0.77*	36.47**	1.97	1.14**	7.15**	8.76**	0.31**	-0.06**
Anna 4	T_2	0.03	-0.70**	1.00	-0.38	-15.13*	-1.38	0.85**	1.05**	-3.41**	-0.07	0.00
Ezhome 1	T_3	-10.27**	-9.62**	0.20	-0.72*	-19.23**	-2.69	-0.59*	-15.95**	2.42*	-0.23**	-0.06**
CSR 23	T_4	6.53**	1.25**	-0.40	0.33	-2.13	2.10	-1.40**	7.75**	-7.77**	-0.01	0.12**
SE		**0.24**	**0.20**	**0.48**	**0.31**	**5.37**	**1.90**	**0.26**	**0.25**	**0.94**	**0.06**	**0.01**

* Significant at 5 per cent level ** Significant at 1 per cent level

DFF – Days to 50% flowering, **PH** – Plant Height, **NPT** – Number of productive tillers per plant, **PL** – Panicle Length, **NFG** – Number of filled grains per panicle, **SFP** – Spikelet fertility percentage, **TGW** – Thousand grain weight, **DM** – Days to Maturity, **SPY** – Single Plant Yield, **AC** – Amylose content, **PC** – Protein content.

Electronic Journal of Plant Breeding, 9 (2) : 753 - 758 (June 2018) DOI: 10.5958/0975-928X.2018.00090.X
ISSN 0975-928X

Table 3. Specific combining ability effects of hybrids for different quantitative and qualitative traits in rice

Genotypes		DFF	PH (cm)	NPT	PL (cm)	NFG	SP (%)	TGW (g)	DM	SPY (g)	AC (%)	PC (%)
TKM 13 / CSR 27	L_1 / T_1	1.28*	2.59**	-2.70*	-1.53*	20.53	4.33	0.41	2.10**	0.64	-0.31*	0.07**
TKM 13 / Anna 4	L_1 / T_2	-0.03	-0.10	2.50*	1.42	0.13	2.63	0.30	6.20**	4.25	0.68**	0.06**
TKM 13 / Ezhome 1	L_1 / T_3	-1.73*	-13.30**	-4.70**	0.56	-57.27**	-6.77	1.40*	-0.80	-7.30**	-0.41**	-0.38**
TKM 13 / CSR 23	L_1 / T_4	0.47	10.82**	4.90**	-0.44	36.63**	-0.19	-2.11**	-7.50**	2.41	0.04	0.24**
MDU 6 / CSR 27	L_2 / T_1	2.78**	5.81**	2.92*	0.63	-31.35*	-0.36	-1.94**	2.60**	-10.66**	-0.34*	-0.53**
MDU 6 / Anna 4	L_2 / T_2	-1.02	-0.58	-5.88**	-1.12	19.75	6.64	-0.24	-5.80**	3.35	-0.06	0.04
MDU 6 / Ezhome 1	L_2 / T_3	0.27	1.34**	6.42**	-1.63*	13.35	-1.42	1.08	2.20**	5.54*	0.18	0.18**
MDU 6 / CSR 23	L_2 / T_4	-2.03**	-6.58**	-3.48**	2.12**	-1.75	-4.87	1.10	1.00	1.77	0.22	0.31**
ASD 16 / CSR 27	L_3 / T_1	-2.22**	-4.98**	0.30	-0.33	7.53	-3.02	-0.38	-1.28*	-4.02	0.77*	0.03
ASD 16 / Anna 4	L_3 / T_2	-1.52*	4.68**	3.50**	0.77	3.63	-1.83	-1.21*	-2.17**	0.59	-0.18	0.21**
ASD 16 / Ezhome 1	L_3 / T_3	-3.23**	-2.62**	-1.20	-1.34	-6.77	5.90	0.52	-2.68**	-2.23	0.10	0.11**
ASD 16 / CSR 23	L_3 / T_4	6.97**	2.92**	-2.60*	0.91	-4.37	-1.05	1.07	6.13**	5.65*	-0.69	-0.35**
ADT 49 / CSR 27	L_4 / T_1	-1.22*	-6.27**	-0.82	1.19	-0.47	1.12	3.24**	-2.40**	2.11	0.43	0.51**
ADT 49 / Anna 4	L_4 / T_2	0.98	8.44**	-2.13	0.89	-8.88	-4.92	2.14**	-1.30*	1.85	-0.50	-0.06**
ADT 49 / Ezhome 1	L_4 / T_3	2.27**	3.20**	3.17**	0.18	16.73	4.81	-2.88**	2.70**	1.47	-0.46	-0.19**
ADT 49 / CSR 23	L_4 / T_4	-2.03**	-5.37**	-0.22	-2.27**	-7.38	-1.01	-2.50**	1.00	-5.43*	0.54	-0.26**
CO (R) 50 / CSR 27	L_5 / T_1	-0.60	2.85**	0.30	0.04	3.78	-2.08	-1.35*	-1.02	11.93**	-0.55	-0.09**
CO (R) 50 / Anna 4	L_5 / T_2	1.60**	-12.44**	2.00	-1.96*	-14.62	-2.52	-1.00	3.08**	-10.04**	0.06	-0.25**
CO (R) 50 / Ezhome 1	L_5 / T_3	2.40**	11.38**	-3.70**	2.23**	33.98*	-2.52	-0.11	-1.43*	2.51	0.59**	0.29**
CO (R) 50 / CSR 23	L_5 / T_4	-3.40**	-1.79**	1.40	-0.32	-23.13	7.11	2.46**	-0.62	-4.40*	-0.10	0.05*
SE		**0.54**	**0.45**	**1.08**	**0.69**	**12.01**	**4.25**	**0.58**	**0.56**	**2.09**	**0.14**	**0.02**

* Significant at 5 per cent level ** Significant at 1 per cent level

DFF – Days to 50% flowering, **PH** – Plant Height, **NPT** – Number of productive tillers per plant, **PL** – Panicle Length, **NFG** – Number of filled grains per panicle, **SFP** – Spikelet fertility percentage, **TGW** – Thousand grain weight, **DM** – Days to Maturity, **SPY** – Single Plant Yield, **AC** – Amylose content, **PC** – Protein content.