Combining Ability Analysis for Yield and Grain Quality Traits in Rice Hybrids.

I. S. Thakare[1], A. M. Mehta[1*], J. S. Patel[2] and S.R Takle[1]

1 *Main Rice Research Station, Anand Agricultural University, Nawagam-387540, Gujarat*. 2 *Department of Agricultural Statistics, B. A. College of Agriculture, Anand Agricultural University, Anand. – 388 110. Gujarat*

Abstract

Combining ability analysis for yield and grain quality traits was carried out in rice through line x tester analysis of 45 hybrids developed by crossing 3 females with 15 male lines along with parents and checks. The 45 hybrids along with 18 parents and three standard checks were grown in a randomized block design with three replications and were evaluated for grain yield per plant and quality traits. The experiments were conducted at Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat in *kharif* 2006 and 2007. The estimates of gca effects indicated that, among females, IR 68886 A and IR 68897 A and among males IR-44, IR-60, IR-9761, IR–4266-29-4-2-2-2, IR-5638-139-2-2, IR–69701-9-3-1 and IR–71138-49-2-2 are good general combiners for grain yield per plant. High sca effects were observed in the crosses, IR 68886 A × IR–44, IR 68897 A × IET–15554, IR 68897 A × IR–56455-206-2, IR 68902 A × IR–4266-29-4-2-2-2 and IR 68897 A × IR–62161-184-3-1-3-2 and they were found to be the best combinations for grain yield per plant and quality traits.

Success of any plant breeding programme depends on the choice of appropriate genotypes as parents in the hybridization programme. The combining ability studies of the parents provide information which helps in the selection of better parents for effective breeding. Combining ability analysis also provides information on addative and dominance variance. Its role is important to decide parents, crosses and appropriate breeding procedure to be followed to select desirable segregants (Salgotra et. al., 2009).

*Corresponding author :
dratulmehta@gmail.com

Accordingly, the present investigation was undertaken to get an idea of the combining ability for yield and quality traits with a view to identify good combiners which may be used to create a population with favourable genes for yield and quality traits in rice.

Materials and Methods

The experimental material comprising of three CMS lines {IR – 68886 A, IR – 68897 A, IR–68902 A} and fifteen testers {IR-40, IR-60, IR–9761, IR–4266-29-4-2-2-2, IR–5638-139-2-2, IR–56455-206-2, IR–60819-34-2, IR–62161-184-3-1-3-2, IR–69701-9-3-1, IR–71138-49-2-2-1-2, GAUR–1, Suraksha, IET–15554, IET–16555, IET–17162 } were selected on the basis of the morphological differences. Crosses were made in line x tester fashion by adopting the "Isolation Free System" design advocated by Virmani and Casal (1993), as well as by pollinating the CMS line by the respective donors. The resulting 45 hybrids along with 18 parents and three standard checks {Gurjari, GR–11 (Inbreds) and KRH–1 (Hybrid)} were grown in randomized block design in three replications at the Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat during *kharif* 2006 and 2007. Each entry was planted in a 3 meter long row with inter and intra row spacing of 20 x 15 cm. One line of each entry was planted in each replication. All the recommended agronomic and plant protection practices were uniformly applied throughout the crop growth period. Five competitive plants were randomly selected to record the observations on grain yield and grain quality characters viz., grain length, grain breadth, length: breadth ratio, hulling percentage, milling percentage and head rice recovery percentage and their mean values were subjected to statistical analysis.

Results and Discussion

Analysis of variance for combining ability (Table 1) revealed that the mean squares due to females (lines) were significant only for grain yield per plant. The variance due to hybrids differed significantly for all the characters. The mean squares due to males (testers) were found non significant for all the characters. Thus, suggesting the importance of heterosis breeding for improvement of rice. Combining ability analysis revealed that both gca and sca variances were important for inheritance of various traits studied. It further revealed the importance of additive and non-additive types of gene actions. The sca variances were higher than the gca variances for almost all the characters, which is in corroboration with earlier findings of Saravanan *et al.* (2006), Anandkumar *et al.* (2004), Vanaja *et al.* (2003).

An overall appraisal of gca effects (Table 2) revealed that among females IR 68886 A and IR 68897 A were good general combiners for grain yield per plant. The parental line, IR 68886 A also had favourable genes for grain yield per plant, length and milling percentage, whereas line IR 68897 A possessed desirable genes for grain yield per plant, milling percentage and head rice recovery. Among the testers IR-44, IR-60, IR-9761, IR–4266-29-4-2-2-2, IR-5638-139-2-2, IR–69701-9-3-1 and IR–71138-49-2-2 were good general combiners for grain yield per plant.

High sca effect results (Table 3) mostly from dominance and interaction effects existed between the hybridizing parents. In the present study, positive significant sca effect for grain yield per plant was exhibited by 5 crosses viz., IR 68886 A × IR–44, IR 68897 A × IET–15554, IR 68897 A × IR–56455-206-2, IR 68902 A × IR–4266-29-4-2-2-2 and IR 68897 A × IR–62161-184-3-1-3-2 indicated the preponderance of non additive gene action involving good x good and good x poor combining parents. Of these five combinations, in addition to grain yield per plant, the cross combinations viz., IR 68886 A × IR-44, IR 68897 A × IET–15554 and IR 68897 A × IR–56455-206-2 registered high and positive sca effects for grain length; cross IR 68902 A × IR–4266-29-4-2-2-2 for grain breadth; whereas, cross IR 68897 A × IR–62161-184-3-1-3-2 for grain length and head rice recovery. These results are in conformity with the earlier findings of Kumar *et al.* (2007), Sarma *et al.* (2007).

From this study it is observed that parental lines IR 68886 A and IR 68897 A among female; IR-44, IR-9761, IR–4266-29-4-2-2-2, IR-5638-139-2-2, IR–69701-9-3-1 and IR-71138-49-2-2 among males and cross combinations, IR 68886 A × IR–44, IR 68897 A × IET–15554, IR 68897 A × IR–56455-206-2, IR 68902 A × IR–4266-29-4-2-2-2 and IR 68897A × IR–62161-184-3-1-3-2 could be exploited beneficially in future rice breeding programme by adopting appropriate breeding strategy in order to evolve high yielding hybrid varieties.

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Table 1: Analysis of variance and variance estimates for combining ability for grain quality traits in rice.

No	SOURCE	Degree of freedom	Grain Yield per Plant (gm)	Grain Length (mm)	Grain Breadth (mm)	Length : Breadth ratio %	Hulling %	Milling %	Head rice recovery (gm)
1	Replication	2	19.69 *	0.01	0.03	1.60 **	85.11 **	18.60	108.65 **
2	Hybrid	44	575.45 **	1.54 **	0.06 **	0.45 **	16.31 **	171.31 **	361.77 **
3	Females	2	3615.49 **	4.30	0.00	0.91	8.90	252.42	300.58
4	Males	14	325.01	1.47	0.09	0.61	18.19	161.90	241.09
5	F X M	28	483.52 **	1.38 **	0.06 **	0.34 **	15.90 **	170.22 **	426.48 **
6	Error	88	5.88	0.02	0.03	0.17	3.362	6.62	5.49
7	σ^2 F		80.15	0.10	0.00	0.02	0.11	5.47	6.53
8	σ^2 M		35.15	0.16	0.01	0.05	1.59	17.30	26.06
9	σ^2 gca		72.65	0.11	0.00	0.02	0.36	7.44	9.79
10	σ^2 sca		158.29	0.45	0.01	0.07	4.02	54.66	139.98
11	σ^2A		290.61	0.42	0.00	0.09	1.44	29.77	39.16
12	σ^2D		633.15	1.81	0.05	0.27	16.07	218.65	559.93
13	σ^2A/σ^2D		0.46	0.23	0.07	0.34	0.09	0.14	0.07
14	Degree of Dominance		1.48	2.07	3.89	1.71	3.34	2.71	3.78

Note: * and ** indicate significance at 5% and 1% level, respectively.

Table 2: Estimates of general combining ability (gca) effects of parents for grain quality traits in rice.

Sr.No	SOURCE	Grain yield per plant (gm)	Grain length (mm)	Grain breadth (mm)	Length to breadth ratio %	Hulling %	Milling %	Head rice recovery (gm)
	Female parents							
1	IR 68886 A	5.72 **	0.23 **	-0.003	0.09	-0.44	1.48 **	-2.23 **
2	IR 68897 A	4.60 **	-0.35 **	0.01	-0.16 **	-0.01	1.25 **	2.83 **
3	IR 68902 A	-10.33**	0.12 **	-0.01	0.07	0.45	-2.73 **	-0.59
	S.Ed.	0.44	0.02	0.02	0.06	0.29	0.37	0.38
	Male parents							
1	IR- 44	9.59 **	-0.59 **	0.084	-0.38 **	-1.62 *	-10.99 **	-11.92 **
2	IR- 60	4.29 **	-0.47 **	0.09	-0.35 **	1.43 *	2.19 **	-2.16 *
3	IR- 9761	3.41 **	-0.15 **	-0.09	0.06	1.05	2.50 **	-6.84 **
4	IR- 4266-29-4-2-2-2	9.23 **	0.13 **	0.00	0.07	-0.91	-1.01	-0.65
5	IR- 5638-139-2-2	4.08 **	-0.24 **	-0.07	0.00	-0.52	1.98 *	3.15 **
6	IR- 56455-206-2	-2.49 *	0.57 **	0.07	0.11	-0.84	-2.20 **	8.66 **
7	IR- 60819-34-2	-5.72 **	0.16 **	-0.056	0.183	0.5	4.36 **	2.369 **
8	IR- 62161-184-3-1-3-2	-1.05	-0.00	0.08	-0.13	-0.47	2.67 **	-4.99 **
9	IR- 69701-9-3-1	2.52 *	-0.33 **	0.07	-0.25 *	-1.15	1.99 *	-0.48
10	IR- 71138-49-2-2-1-2	2.65 **	0.57 **	-0.07	0.35 **	3.03 **	6.20 **	4.99 **
11	GAUR– 1	-1.40	-0.62 **	-0.09	-0.13	-1.16	-1.53	1.00
12	Suraksha	-9.03 **	0.24 **	0.02	0.06	2.49 **	-5.85 **	-0.52
13	IET- 15554	-0.93	0.50 **	-0.01	0.22	-1.25	-1.37	0.77
14	IET- 16555	-3.76 **	-0.12 *	0.18 **	-0.32 *	-0.70	1.68 *	6.19 **
15	IET- 17162	-11.39 **	0.34 **	-0.20 **	0.50 **	0.08	-0.61	0.44
	S.Ed.	0.98	0.05	0.05	0.12	0.65	0.83	0.85

Note: * and ** indicate level of significance at 5% and 1%, respectively.

Table 3: Estimates of specific combining ability (sca) effects for grain quality traits in rice.

Sr. No	Hybrids	Grain yield per plant (gm)	Grain Length (mm)	Grain Breadth (mm)	Length : breadth Ratio %	Hulling %	Milling %	Head rice recovery (gm)
1	IR 68886 A × IR - 44	37.43 **	1.24 **	0.10	0.35	0.59	1.57	0.93
2	IR 68886 A × IR – 60	-4.74 **	0.47 **	0.07	0.09	-0.56	0.69	-3.77 *
3	IR 68886 A × IR – 9761	5.00 **	0.31 **	0.03	0.10	0.08	-1.82	-1.06
4	IR 68886 A × IR – 4266-29-4-2-2-2	-7.54 **	0.68 **	-0.23 *	0.71 **	-0.07	-2.34	-1.19
5	IR 68886 A × IR – 5638-139-2-2	-0.83	0.04	0.03	-0.01	1.79	-2.54	-6.18 **
6	IR 68886 A × IR – 56455-206-2	-11.66 **	-0.51 **	-0.05	-0.13	-2.2	-1.55	22.59 **
7	IR 68886 A × IR – 60819-34-2	0.77	0.03	0.07	-0.13	0.18	0.07	-11.45 **
8	IR 68886 A× IR – 62161-184-3-1-3-2	-4.43 *	-0.71 **	-0.10	-0.13	0.68	3.59 *	-10.28 **
9	IR 68886 A × IR – 69701-9-3-1	-1.06	-0.40 **	-0.07	-0.05	0.62	-0.36	-0.15
10	IR 68886 A× IR – 71138-49-2-2-1-2	-4.68 **	0.44 **	0.10	0.01	-3.32 **	-1.98	-4.40 **
11	IR 68886 A× GAUR – 1	-0.78	0.38 **	-0.01	0.19	1.81	-2.01	-2.26
12	IR 68886 A × SURAKSHA	-4.97 **	-1.16 **	0.08	-0.60 **	-1.75	7.46 **	11.69 **
13	IR 68886 A× IET – 15554	-6.09 **	-0.37 **	0.09	-0.31	0.22	0.55	12.97 **
14	IR 68886 A × IET – 16555	-4.46 *	-0.02	-0.19 *	0.27	1.54	-0.60	-8.12 **
15	IR 68886 A × IET – 17162	8.03 **	-0.41 **	0.10	-0.36	0.39	-0.74	0.67
16	IR 68897 A× IR - 44	-17.83 **	-0.31 **	-0.17	0.12	1.91	11.98 **	-2.91
17	IR 68897 A × IR – 60	-1.42	-0.44 **	-0.14	0.03	1.55	-1.58	13.63 **
18	IR 68897 A × IR – 9761	-14.34 **	-0.85 **	-0.17	-0.09	-1.35	0.56	3.84 *
19	IR 68897 A × IR – 4266-29-4-2-2-2	-9.09 **	-0.76 **	-0.05	-0.28	0.48	1.39	6.12 **
20	IR 68897 A × IR – 5638-139-2-2	-11.25 **	-0.76 **	-0.07	-0.23	-0.78	1.12	6.89 **
21	IR 68897 A × IR – 56455-206-2	14.83 **	0.66 **	0.075	0.16	0.09	-2.28	-28.21 **
22	IR 68897 A × IR – 60819-34-2	3.21	-0.45 **	0.14	-0.43 *	1.1	-0.67	11.41 **
23	IR 68897 A × IR– 62161-184-3-1-3-2	11.50 **	0.55 **	0.16	-0.00	-0.80	-4.95 **	5.94 **
24	IR 68897 A × IR – 69701-9-3-1	6.12 **	0.17 *	0.12	-0.09	0.11	-2.79	-7.04 **
25	IR 68897 A × IR – 71138-49-2-2-1-2	1.36	-0.21 *	0.01	-0.11	-4.33 **	-8.69 **	-10.99 **
26	IR 68897 A × GAUR – 1	6.66 **	0.25 **	0.01	0.09	-0.71	-3.293 *	2.68
27	IR 68897 A × SURAKSHA	0.28	0.69 **	-0.04	0.36	3.04 **	15.75 **	9.67 **
28	IR 68897 A × IET – 15554	13.38 **	0.76 **	0.08	0.18	0.19	-5.63 **	-16.02 **
29	IR 68897 A × IET – 16555	6.94 **	-0.02	0.10	-0.13	-0.49	-2.19	2.20
30	IR 68897 A × IET – 17162	-10.36 **	0.72 **	-0.05	0.42	-0.07	1.27	2.81
31	IR 68902 A × IR - 44	-19.60 **	-0.93 **	0.07	-0.47 *	-2.49 *	-13.55 **	1.98
32	IR 68902 A × IR – 60	6.16 **	-0.03	0.08	-0.13	-1.00	0.89	-9.86 **
33	IR 68902 A × IR – 9761	9.34 **	0.54 **	0.14	-0.01	1.26	1.26	-2.78
34	IR 68902 A × IR – 4266-29-4-2-2-2	16.63 **	0.08	0.28 **	-0.43 *	-0.40	0.95	-4.93 **
35	IR 68902 A × IR – 5638-139-2-2	10.08 **	0.72 **	0.04	0.24	-1.02	1.42	-0.70
36	IR 68902 A × IR – 56455-206-2	-3.18	-0.15	-0.02	-0.03	2.11	3.83 **	5.63 **
37	IR 68902 A × IR – 60819-34-2	-3.98 *	0.42 **	-0.21 *	0.56 **	-1.33	0.59	0.03
38	IR 68902 A × IR – 62161-184-3-1-3-2	-7.07 **	0.16	-0.05	0.13	0.12	1.36	4.345 **
39	IR 68902 A × IR – 69701-9-3-1	-5.06 **	0.23 *	-0.04	0.14	-0.72	3.15 *	7.20 **
40	IR 68902 A × IR – 71138-49-2-2-1-2	3.32	-0.23 **	-0.11	0.10	7.64 **	10.67 **	15.38 **
41	IR 68902 A × GAUR – 1	-5.88 **	-0.63 **	0.00	-0.29	-1.10	5.29 **	-0.42
42	IR 68902 A × SURAKSHA	4.69 **	0.47 **	-0.04	0.24	-1.28	-23.21 **	-21.36 **
43	IR 68902 A × IET – 15554	-7.29 **	-0.39 **	-0.17	0.13	-0.41	5.07 **	3.05 *
44	IR 68902 A × IET – 16555	-2.49	0.036	0.09	-0.14	-1.06	2.79	5.92 **
45	IR 68902 A × IET – 17162	2.32	-0.30 **	-0.04	-0.06	-0.33	-0.53	-3.48 *
	S. Ed.	1.70	0.09	0.09	0.21	1.13	1.44	1.48

Note: * and ** indicate level of significance at 5% and 1 %, respectively.