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Study of combining ability analysis in rice (*Oryza sativa* L.) under coastal salt affected soil

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Abstract
Combining ability analysis indicated the importance of both additive and non-additive gene action for the inheritance of all the characters; however the ratio of σ^2 gca/σ^2 sca revealed the preponderance of additive gene action for plant height, days to 50% flowering and kernel length while Grains per panicle, Grain yield / plant, Kernel breadth, Amylose content (%), Protein conte nt (%), K+ / Na+ ratio in Shoot and K+ / Na+ ratio in root showed predominance of non -additive gene action. An observation of the general combining ability effects suggested that female parent Gurjari was found to be good general combiner for majority of the traits, while male parents viz., IET -19347, GNR-2, GAR-1 and IR- 71907 were best general combiner for grain yield per plant and also for number of yield components and biochemical characters. GNR -3 and IR- 55179 were identified as the most promising parents for im parting dwarfness and earliness, respectively.
Estimates of sca effects did not reveal any specific trend. However, the comparison of sca effects with per se performance of crosses indicated that at least one good general combiner was necessary for better per se performance along with sca effects. The hybrids which recorded maximum significant positive sca effects for grain yield were IET -21734 x Jaya, Gurjari x GAR-1 and GNR-3 x IET-22608. Higher K+/Na+ ratio in shoot and root were found in salt tolerance genotypes these biochemical traits can be utilized as marker characters in salt tolerance breeding programme in rice.

Keywords: rice, combining ability, salt tolerance

Introduction
India is the largest rice growing country in the world, but its productivity per unit area by world standard is low. While in case of Gujarat, it occupies about 5% of the gross cropped area and it is grown on about 6.5 to 7.3 lakh hectares which comprises nearly 55 to 60 % of lowland and 40 to 45 % of upland situation. About 45% of the area under rice is confined to South Gujarat (Anon., 2008) [2]. The salinity and sodicity are the important factors adversely affecting the soil health and crop production. It is estimated that half of the world farmers have been damaged by salt. It has been estimated that about one billion hectare of the world land is affected by salt 60% of which is cultivated. The total salt affected area in india approximately 8.1 m ha, out of which 32 m ha coastal saline (Anon., 2009) [2]. Total salt affected area in Gujarat is 1.2 lakh ha, in south Gujarat alone around 70,000 ha area is salt affected.

Materials and Methods
The experimental material for the present investigation consists of 14 parents (4 Females and10 males), their 40 crosses and 2 varieties *viz*., Dandi and CST-7-1 as standard checks. The seeds of these parents were obtained from Coastal Soil Salinity Research Station, Danti - Umbharat and Main Rice Research Centre, N.A.U., Navsari. Three complete sets of 56 entries comprising of 40 F_1's, 4 females, 10 males and 2 checks were evaluated during *kharif* 2012. The experiment was laid out in a randomized block design replicated three times at research station of the university *viz*., Coastal Soil Salinity Research Station, Danti - Umbharat. The parents an d F_1's were represented by a single row plot of 10 plants placed at 20 cm x 15 cm spacing.

Results and Discussion
The results and discussion of fifteen quantitative traits are grouped into plant morphological traits, yield and yield attributing traits and economic traits.

Analysis of variance for combining ability
The estimation of general combining ability (gca) variances for females (σ^2f) were significant for all the characters except grain yield per plant, kernel breadth, amylose content and K^+/Na^+

ratio in root, also general combining ability (gca) variances for males (σ^2 m) significant only for days to 50% flowering. On the other hand, specific combining ability (sca) variances for f x m interaction were highly significant for all characters except plant height. The magnitude of gca variances was lower than sca variances for various characters except plant height, days to 50% flowering and kernel length which indicated the predominance of non - additive gene action. This was further supported by low magnitude of σ^2gca/σ^2sca ratios. General combining ability effects of females (Gj) and of males (Gi) as well as specific combining ability eff ects of crosses (Sij) for all the characters were also estimated. This was further supported by low magnitude of σ^2gca/σ^2sca ratios. The findings are in confirmation with Dhaliwal and Sharma (1990) [5], Satyanarayana *et al*. (1998) [11], Annadhurai and Nadarajan (2001) [1], Sharma (2006) [12], Pradhan and Singh (2008) [8], Sharma and Mani (2008) [13] and Salgotra *et al*. (2009) [9] in rice.

Table 1.1: Analysis of variance for combining ability for different characters in rice

Source of variation	d.f.	Plant height (cm)	Days to 50% flowering	Grain yield per plant (g)	Kernel length (mm)	Kernel breadth (mm)	Amylose content (%)	Protein content (%)	K^+/Na^+ ratio of shoot	K^+/Na^+ ratio of root
Replicati on	2	16.17	64.99*	1.49	0.02	0.02	0.29	0.10	0.05	0.0002
Female	3	917.28*	155.46**	408.63	3.22**	0.21	17.82	18.26*	20.60**	0.10
Male	9	200.24	394.09**	113.97	0.72	0.13	13.17	7.89	3.49	0.06
Female x male	27	207.03	31.02**	142.36**	0.39	0.09**	11.78**	5.52**	4.15**	0.05
Error	78	186.52	14.52	5.43	0.21	0.03	1.00	0.12	0.003	0.0002
Estimates										
σ^2 f		25.48*	4.58**	13.44	0.10**	0.01	0.56	0.60*	0.69**	0.003
σ^2 m		3.96	31.34**	9.04	0.04	0.01	1.01	0.65	0.29	0.004
σ^2 gca		19.334**	12.228**	12.182*	0.084**	0.007**	0.686*	0.617**	0.573**	0.004*
σ^2 sc a		18.092	4.348*	45.631**	0.061*	0.018**	3.565**	1.804**	1.374**	0.017**
σ^2 gca/ σ^2 sca		1.069	2.812	0.267	1.382	0.362	0.193	0.342	0.417	0.220

Estimates of general and specific combining ability effects

The estimates of general combining ability (gca) effects of parents and specific combining ability (sca) effects of hybrids for different traits are presented in Table 1.1, 1. 2 and 1.3. Nature and magnitude of combining ability effects provide guideline in identifying the better parents and their utilization The summery of general combining ability effects of the parents revealed that none of the parents found to be good general combiner for all the characters. Among the females, GNR -3 was found to be good gen eral combiner for plant height, kernel breadth, amylose content and protein content. IET-15429 was found to be good general combiner for kernel length, kernel breadth, protein content, K^+/Na^+ ratio in shoot and K^+/Na^+ ratio in root. Female, Gurjari was found to be good general comb iner for days to 50% floweri ng, grain yield per plant, K^+/Na^+ ratio in shoot and K^+/Na^+ ratio in root and IET-21734 was found to be good general combiner for grain yield per plant and amylose content. An overall appraisal of gca effects revealed that among males, IET-22608 emerged out as good general comb iner for days to 50% flowering, protein content, K^+/Na^+ ratio in shoot and K^+/Na^+ ratio in root, whereas AT-401 male, traced out good general combiner for kernel length and protein content. GNR -2 emerged out as good general comb iner for grain yield per plant, K^+/Na^+ ratio in shoot and K^+/Na^+ ratio in root and Jaya for days to 50 flowering, amylose content and K^+/Na^+ ratio in root. IET-19347 was found to be good general combiner for days to 50% flowering, grain yield per plant, kernel length, kernel breadth, K^+/Na^+ ratio in shoot. Male, SPRV-1 was found to be good general combiner for amylose content and protein content. GAR -1 was found to be good general combiner for grain yield per plant, K^+/Na^+ ratio in root, whereas IR -71907

male, traced out good general combiner for grains yield per plant and protein content. Male IR-55179 was found to be good general comb iner for days to 50% flowering, protein content and K^+/Na^+ ratio in root. These results are getting support from the findings of Singh and Singh (1991) [16], Singh *et al.* (1992) [15], Kumar *et al*.(2006) [6], Sharma (2006) [12], Singh *et al*.(2007) [10], Parihar and Pathak (2008) [7], Sharma and Mani (2008) [13] and Tyagi *et al*.(2008) [18].

High sca denotes undoubtedly a high heterotic response, but this may be due to p oor performance of the parents in comparison with their hybrids. With the same amount of heterotic effect, the sca may be less, where the mean performance of the parents was higher but this estimate may also be biased (Ziauddin *et al*., 1979) [19]. This suggested that the selection of cross combination based on heterotic response would be more realistic rather than on the basis of sca effects.

The best specific combination IET-21734 x Jaya also recorded the desirable significant sca effect s for traits of grain yield per plant, K^+/Na^+ ratio in root. The second best cross *i.e*., Gurjari x GAR-1 had desirable significant sca effects for grain yield per plant, amylose content, protein content and K^+/Na^+ ratio in root, whereas the third best cros s GNR-3 x IET-22608 had significant sca effects for grain yield per plant, whereas the fourth best cross Gurjari x IET-19347 had significant sca effects for grain yield per plant These results are getting support from the findings of kumar *et al*.(2006) [6], Sinha *et al*.(2006) [17], Sharma *et al*.(2006) [12], Sarial *et al*. (2007) [10], Singh *et al*.(2007) [14], Parihar and Pathak (2008) [7] and Pradhan and Singh (2008) [8].

On the basis of heterosis and combining ability, it can be observed that there is some degree of relationship between heterosis and specific combining ability effects. In most of the cases, for most of the characters, the best specific cross combinations for various characters manifested the maximum or near to maximum heterosis for the characters.

On the basis of heteros is and combining ability the most promising parents for yield attributing traits were Gurjari, IET-19347, and GNR-2, Most promising hybrids were Gurjari x GAR-1, Gurjari x IET-19347, IET-21734 x Jaya and IET-21734 x GNR-2

Table 1.2: Estimation of general combining ability effects of parents for different characters in rice.

Parents	Plant height (cm)	Days to 50% flowering	Grain yield per plant (g)	Kernel length (mm)	Kernel breadth (mm)	Amylose content (%)	Protein content (%)	K^+/Na^+ ratio of shoot	K^+/Na^+ ratio of root
Females									
GNR-3	-5.94*	-1.26	-3.23**	0.004	-0.01	0.78**	0.751**	-1.13**	-0.08 **
IET-15429	4.67*	0.86	-2.53**	0.35**	-0.11**	-0.60**	0.57**	0.67**	0.01***
GURJARI	4.75*	-2.35**	4.80**	0.09	0.096**	-0.72**	-0.81**	0.58**	0.07 ***
IET-21734	-3.48	2.77**	0.96*	-0.44**	0.01	0.54**	-0.52**	-0.12**	-0.01
S Em. ± (gj)	2.26	0.77	0.43	0.08	0.03	0.19	0.06	0.03	0.003
S Em. ± (gi - gj)	3.19	1.09	0.60	0.12	0.05	0.27	0.09	0.04	0.004
Males									
IET-22608	-5.52	-5.65**	-1.15	0.31*	0.06	-1.66**	0.747**	0.123**	0.10**
AT-401	3.05	6.78**	-4.16**	-0.11	-0.05	-0.32	0.45**	-0.82**	-0.14**
GNR-2	1.73	-1.17	3.80**	-0.02	-0.004	-0.14	-0.38**	0.55**	0.06**
JAYA	0.11	-2.74*	0.24	0.14	0.02	0.86**	-0.95**	-0.39**	0.03**
IET-19347	1.30	-6.08**	3.83**	0.41**	-0.24**	-0.05	0.19	1.12**	-0.07***
SPRV-1	-3.68	-1.42	-3.54**	-0.18	0.05	2.00**	0.30**	-0.05	-0.01**
GAR-1	-1.29	2.34	3.55**	-0.16	0.16**	0.21	-1.31**	-0.04	0.04**
IR-71895-3R-9-3-1	1.57	9.54**	-1.52*	0.11	-0.05	0.52	-0.08	-0.19**	-0.02**
IR-71907-3R-2-1-2	-5.12	5.20**	1.69*	0.09	0.01	-0.03	-0.41**	0.119**	-0.002
IR-55179-3B-11-3	7.86*	-6.80**	-2.73**	-0.41	0.091	-1.41**	1.45**	-0.41**	0.02**
S Em. ± (gj)	3.57	1.22	0.68	0.13	0.05	0.30	0.10	0.04	0.004
S Em. ± (gi - gj)	5.05	1.73	0.95	0.19	0.08	0.43	0.14	0.06	0.01

Table 1.3: Estimation of SCA effects for plant height (cm) & various characters in rice

Crosses	Plant height (cm)	Days to 50% flowering	Grain yield per plant (g)	Kernel length (mm)	Kernel breadth (mm)	Amylose content (%)	Protein content (%)	K^+/Na^+ ratio of shoot	K^+/Na^+ ratio of root
GNR-3 x IET-22608	-11.01	1.49	10.69**	-0.05	0.16	-0.04	-0.76**	-0.89**	-0.10**
GNR-3 x AT-401	-4.85	-1.75	0.03	0.32	-0.25*	-1.45*	1.30**	0.25**	-0.002
GNR-3 GNR-2	-6.19	2.14	-3.78**	-0.89**	0.10	-1.50*	-2.22**	0.71**	-0.02*
GNR-3 x JAYA	-3.56	-1.32	-3.37*	0.17	0.28*	-2.86**	1.56**	0.10	0.02
GNR-3 x IET-19347	6.27	0.07	-10.08**	0.06	-0.03	-0.37	-0.20	-0.96**	0.05**
GNR-3 x SPRV-1	4.69	1.58	0.39	0.09	0.13	3.05**	0.70**	-0.51**	-0.05**
GNR-3 X GAR-1	2.25	0.48	-5.58**	-0.02	-0.02	0.79	-0.88**	0.49**	-0.05**
GNR-3 X IR-71895	5.28	0.03	-1.33	-0.28	0.09	-0.62	0.23	0.90**	0.06**
GNR-3 X IR-71907	5.15	-0.58	6.74**	0.48	-0.12	-0.11	-0.23	0.20*	0.15**
GNR-3 X IR-55179	1.97	-2.15	6.28**	0.13	-0.30**	3.11**	0.49*	1.13**	-0.02*
IET-15429 X IET-22608	7.60	1.23	-0.40	-0.15	-0.05	-1.37*	0.63**	-0.84**	-0.15**
IET-15429 X AT-401	-6.77	2.09	1.33	-0.24	-0.01	0.79	-0.25	-0.40**	-0.01
IET-15429 X GNR-2	-0.52	0.26	7.88**	0.09	0.05	0.38	1.75**	-0.22*	-0.20**
IET-15429 X JAYA	-1.65	2.81	-3.60**	-0.16	-0.17	2.27**	-0.95**	-0.51**	-0.07**
IET-15429 X IET-19347	-9.90	3.50	-3.00*	-0.37	0.13	2.89**	-0.09	-0.97**	-0.01
IET-15429 X SPRV-1	6.30	-2.44	0.93	0.36	-0.15	0.41	-2.12**	1.35**	0.10**
IET-15429 X GAR-1	-0.13	-3.31	-2.38	-0.07	-0.15	-0.12	-1.27**	-0.68**	-0.01
IET-15429 X IR-71895	-3.72	-2.28	1.93	0.04	0.09	-0.89	-0.81**	0.87**	0.17**
IET-15429 X IR-71907	-7.55	-1.15	-1.40	0.14	-0.06	-0.92	0.39*	1.94**	0.04**
IET-15429 X IR-55179	-16.34*	-0.70	-1.30	0.37	0.32**	-3.44**	2.71**	-0.54**	0.13**

Contd…. Table 4.4.3

Crosses	Plant height (cm)	Days to 50% flowering	Grain yield per plant (g)	Kernel length (mm)	Kernel breadth (mm)	Amylose content (%)	Protein content (%)	K^+/Na^+ ratio of shoot	K^+/Na^+ ratio of root
GURJARI X IET-22608	-5.99	1.23	-6.01**	0.12	0.09	0.11	-0.17	1.28**	0.25**
GURJARI X AT-401	17.62*	-4.59	0.06	0.06	0.17	-1.33*	0.15	-0.32**	0.05**
GURJARI X GNR-2	9.19	-0.98	-11.36**	0.56*	0.08	1.82**	0.65**	2.52**	0.19**
GURJARI X JAYA	-2.11	-0.18	-5.83**	0.01	-0.13	2.38**	-0.07	1.07**	-0.12**
GURJARI X IET-19347	-0.47	0.60	8.39**	-0.37	-0.12	-2.29**	1.02**	-0.08	-0.09**
GURJARI X SPRV-1	-9.33	4.43	3.08*	0.06	-0.06	-1.43*	0.06	-1.02**	-0.14**
GURJARI X GAR-1	1.91	-0.43	12.71**	0.04	0.13	1.39*	0.83**	-0.38**	0.181**
GURJARI X IR-71895	1.84	-4.53	4.64**	0.13	-0.19	0.67	-0.54**	-0.73**	-0.15**
GURJARI X IR-71907	-2.54	0.25	-4.07**	-0.17	0.03	-0.59	0.89**	-1.61**	-0.08**
GURJARI X IR-55179	-10.11	4.20	-1.61	-0.44	-0.01	-0.72	-2.82**	-0.73**	-0.10**
IET-21734 X IET-	9.39	-3.95	-4.28**	0.09	-0.20	1.30*	0.29	0.46**	0.03**

22608									
IET-21734 X AT-401	-5.99	4.26	-1.42	-0.14	0.09	2.00**	-1.20**	0.47**	-0.04**
IET-21734 X GNR-2	-2.48	-1.42	7.26**	0.24	-0.23*	-0.69	-0.18	-1.59**	0.03**
IET-21734 X JAYA	7.33	-1.32	12.79**	-0.02	0.03	-1.79**	-0.55**	-0.67**	0.176**
IET-21734 X IET-19347	4.10	-4.16	4.68**	0.68*	0.02	-0.23	-0.74**	2.00**	0.05**
IET-21734 X SPRV-1	-1.66	-3.58	-4.41**	-0.50	0.08	-2.03**	1.36**	0.18*	0.09**
IET-21734 X GAR-1	-4.02	3.25	-4.75**	0.05	0.03	-2.06**	1.32**	0.57**	-0.13**
IET-21734 X IR-71895	-3.39	6.78**	-5.24**	0.11	0.001	0.85	1.12**	-1.03**	-0.08**
IET-21734 X IR-71907	4.94	1.48	-1.26	-0.45	0.19	1.61**	-1.05**	-0.52**	-0.11**
IET-21734 X IR-55179	-8.20	-1.34	-3.38*	-0.06	-0.01	1.05	-0.38	0.13	-0.02*
S Em.$\pm$ (S_{ij}-S_{kl})	10.09	3.46	1.91	0.37	0.15	0.85	0.27	0.12	0.01
S Em.$\pm$ (S_{ij}-S_{ik})	7.14	2.45	1.35	0.27	0.11	0.60	0.19	0.09	0.01

Summary

The general combining ability effect enables the identification of desirable male and female parents. Female Parent, Gurjari as found to be good general combiner for most of the yield attributes while male parent, IET-19347 as found to be good general comb iner for most of the yield attributes. Parents *viz.*, Gurjari, IET-19347, GNR-2, GAR-1, IR- 71907 and IET-21734 were good general combiners for grain yield per plant as well as one or more of its yield contributing traits and also biochemical characters.

Best three hybrids on the basis of significant positive sca effects for grain yield per plant were IET-21734 x Jaya, Gurjari x GAR -1 and GNR-3 x IET-22608. These crosses also registered high and positive sca effects for most of its yield attributes. The highest significant sca effects in desired direction for Salt tolerance was exhibited by Gurjari x GNR-2, IET-21734 x IET-19347 and IET-15429 x IR-71907 for K^+/Na^+ ratio of shoot, Gurjari x IET-22608, Gurjari x GNR-2 and Gurjari x GAR -1 for K^+/Na^+ ratio of root.

References

1. Annadurai A, Nadarajan N. Madras Agri. J. 2001; 88(4-6):300- 303.
2. Anonymous. Annual Progress Report (Rice). AICRP on RICE, Main Rice Research Station, Nawagam, AAU, Anand, 2008.
3. Anonymous. Annual Progress Report (Rice). AICRP on Rice, Directorate of Rice Research, Hyderabad, 2009.
4. Anonymous. Annual Report. Directorate of Rice Research, Hyderabad, 2010.
5. Dhaliwal TS, Sharma HI. Oryza. 1990; 27:122-125.
6. Kumar A, Singh NK, Sharma VK. Oryza. 2006; 43(2):82-86.
7. Parihar A, Pathak AR. Indian J Crop Sci. 2008; 3(1):169-171.
8. Pradhan SK, Singh S. Oryza. 2008; 45(3):193-197.
9. Salgotra RK, Gupta BB, Singh P. Oryza. 2009; 46(1):12-16.
10. Sarial AK, Sarial SS, Singh VP. Indian J Genet. 2007; 67(2):156-160.
11. Satyanarayana PV, Kumar T, Reddy MSS. IRRN. 1998; 23(3):10.
12. Sharma RK, Indian Jour. Genet. 2006; 66(3):227-228.
13. Sharma RK, Mani SC. Oryza, 2008; 45(2):94-97.
14. Singh NK, Kumar A, Kumar R. Oryza, 2007; 44(2):156-159.
15. Singh NK, Singh NB, Jha PB, Sharma VK. Ann. Agric. Res., 1992; 13(3):224-227.
16. Singh R, Singh A. Oryza, 1991; 28:19-22.
17. Sinha PK, Mandal NP, Prasad C, Prasad K. Oryza. 2006; 43(1):5-9.
18. Tyagi JP, Singh T, Singh VP. Oryza. 2008; 45(3):235-238.
19. Ziauddin AK, Katiyar P, Gupta RR. Indian J Genet. 1979; 39(2):279-284.