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Combining ability for yield component and physiological traits in hybrid rice

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Abstract : Combining ability estimates were obtained from line x tester analysis of crosses involving five male sterile lines and seven pollinator varieties. Predominance of non-additive gene action was observed for all the characters studied. Ponni for productive tillers per plant and total drymatter accumulation and IR 58025 A for grain yield per plant and total drymatter accumulation were identified as superior parents with high *per se* performance and significant *gca* effects. The cross combinations V 20A X IR 50400-64-1-2-2-2, PMS 10A X Ponni and IR 6829A BR 736-20-3-1 were found to be the best specific combiners. The crosses showing significant *sca* for grain yield per plant were obtained from good X good, good X poor, poor X good and poor X poor combinations. ***(Key Words*** **:** Rice, Combining ability, *gca, sca).*

Hybrid rice has the unique advantage of better physiological efficiency with wider environmental adaptation. The major requirements for hybrid rice breeding programme are parental lines *viz*., CMS lines and effective restorers for the CMS lines. Restorers which combine well with CMS lines for yield and its component traits will be more useful in the process of development of rice hybrids. Present study was made to know, the general combining ability of parents, the specific combining ability of hybrids for grain yield and other yield component and physiological characters and to study the nature of gene action involved in expression of these traits by adopting Line X Tester Mating design.

Materials and Methods

The material of the present study consists of five CMS lines viz., PMS 9A, PMS 10A, V 20A, IR 58025A and IR 62829, seven restorers *viz*.,BR 736-20-3-1, IR 31406, IR 50400-64-1-2-2-2, IR 8866-20-3-1-4-2, MDU 3, MDU 4 and Ponni and their 35 hybrids. All the 47 genotypes were raised during *Rabi* 1996-97 at Agricultural College and Research Institute, Madurai in a randomized block design with two replications adopting a spacing of 20 x 10 cm. A population of ten plants per replication per genotype was maintained by planting single seedling per hill. Standard agronomic practices were followed to raise the crop. The observations were made on four yield component traits viz., productive tillers per plant (PTP), filled grain per ear (FGE), 100 grain weight (100 GW) and grain yield per plant (GYP) and also on four physiological traits viz., leaf area index (LAI), total chlorophyll content (TCC), total drymatter accumulation (TDMA) and harvest index (HI). Standard statistical procedures were followed for analysis of variance (Panse and Sukhatme., 1964) and combining ability (Kempthorne., 1957)

Results and Discussion

Analysis of variance

The analysis variance for RBD revealed significant difference among 47 genotypes for the all characters. The *sca* variance was greater than *gca* variance revealing the predominance of non additive gene action controlling these traits (Table 1). Earlier workers, Ramalingam *et al.* (1993) for PTP and FGE, Koushik and Sharma (1988) for 100 GW and GYP and Wilfred Manual and Rangaswamy (1995) for TDMA and HI also reported the superiority of non-additive gene action for these characters. Nguyen ThiLang and Buu Chi Buu (1993) stressed the importance of additive gene action for LAI which was in contrary to the present result.

Evaluation of parents and hybrids

The *per se* performance of the parents and superior hybrids for grain yield is presented in Tables 1 and 2 in parentheses. Among the parents MDU 4, 'onni, and IR 58025A and among the hybrids, IR 62829A (BR 736-20-3-1, IR 58025A X MDU 4 and PMS 9 A X R 50400-64-1-2-2-2 found superior for the different traits tudied. According to Gilbert (1958), the hybrids with ood mean performance were always produced by arents with higher mean expression. In the present ivestigation, the hybrids with high *per se* performance iz., IR 58025A X MDU 4 for GYP and TDMA and IR 3025A X Ponni for LAI and TDMA had both the prents with high mean values. However, in contrary o this superior hybrids were also obtained from high low combinations for FGE, 100 GW, GYP, LAI and DMA and also from low X high combination for all e eight yield component and physiological traits. is was in agreement with the report of Varshney 985). Moreover low X low combinations also oduced superior hybrids for most of traits studied. ri Singh (1988) obtained similar results. Hence it was ar that the performance of hybrids was independent the *per se* performance of the parents, and therefore *per se* performance of the hybrids, not that of rents should be taken into account while selecting perior hybrids.

The general combining ability of parents are esented in Table 2. Among the seven male parents, nni was found to be good general combiner for five racters viz., PTP, 100 GW, GYP, TDMA and HI. This s followed by IR 8866-20-3-1-4-2 which showed its perior *gca* effects for FGE, 100 GW and TCC. Among lines PMS 9A was found good general combiner FGE, LAI, TCC and HI. The other lines which owed high *gca* effects were IR 62829A for PTP, TCC, d HI and IR 58025A for GYP, TDMA and HI. Jain ng Peng and Virmani (1990) suggested that it would better to select atleast one parent possessing high neral combining ability to get good progenies.

Considering *sca* effects as the criterion to select standing cross combinations, 11 hybrids for PTP, en for FGE, six for 100 GW, ten each for GYP and I, 15 for TCC, 12 for TDMA and 15 for HI recorded nificantly superior *sca* effects. Out of 35 hybrids studied, the hybrid V 20A X IR 50400-64-1-2-2-2 excelled others with significantly superior *sca* effects for six characters viz., GYP, 100 GW, LAI, TCC, TDMA and HI. This was followed by the hybrids viz., PMS 9A X IR 50400-64-1-2-2-2 for GYP, PTP, FGE, LAI and TDMA, PMS 10A X Ponni for PTP, GYP, TCC, TDMA and HI and IR 62829AX BR 736-20-3-1 for GYP,FGE,TDMA and HI. It was observed from the perusal of *sca* effects of top ranking ten crosses for grain yield per plant (Table 3) that crosses with significant *sca* effects were due to the combination of either poor X poor combiners or poor X good or good X poor. In this study, both the parents of crosses viz., V 20A XIR 50400-64-1-2-2-2 and PMS 9A X IR 50400-64-1-2-2-2 showing significant *sca* effects for grain yield, were found to be poor combiners. Amirthadevarathinam (1983) reported similar results. Such behaviour has been attributed to the overdominance and epistasis type of interaction (Rahman *et al.*, 1981). Poor X good combiners also produced the best crosses *viz.*, PMS 10A X Ponni and IR 62829A K BR736-20-3-1. It was already reported that, in the crosses having higher *sca* effects with good X poor combining parents, the high yield potential was attributed to interaction between positive alleles from good combiners and negative alleles from poor combiners (Dubey, 1975).

Overall, the present study revealed that Ponni, IR 8866-20-3-1-4-2, PMS 9A, IR 62829A and IR 58025A were good general combiners. But the hybrid IR 58025 A X Ponni involving the best general combiners did not show significant positive *sca* effects for higher yield. Similarly Anandakumar and Subramanian (1994) reported the negative *sca* effects for the crosses involving parents of high *gca* in rainfed rice. However the following crosses PMS 9A X IR 50400-64-1-2-2-2, PMS 10A X Ponni and IR 62829A X BR 736-20-3-1 having any one of the parents with high *gca* effects and the hybrid with high *per se* performance and *sca* effects could be exploited in further breeding programme.

Table 1. Analysis of variance for combining ability

Source of variation	Degrees of freedom	Productive tillers per plant	Filled grains per ear	100 grain weight	Grain yield per plant	Leaf area index	Total chlorophyll content	Total drymatter accumulation	Harvest index
Replication	1	0.66	10.00	0.01	3.96	0.42	0.01	17.88	0.08
Genotypes	46	18.48**	682.23**	15.71**	46.85**	1.62**	37.64**	161.10**	50.34**
Line	4	25.95**	259.25**	0.02	36.22**	1.17**	0.44**	52.23**	39.70
Tester	6	9.41**	361.27**	0.11	83.32**	0.38**	0.25**	108.08**	72.55**
Line X Tester	24	17.97**	467.15**	0.09	61.97**	1.50**	0.08**	145.35**	63.09**
Error	46	0.84	21.83	0.01	1.20	0.11	0.01	4.53	1.94
GCA variance		0.023	18.168	0.001	1.183	0.059	0.028	5.432	0.580
SCA Variance		8.565	253.22	0.035	30.384	0.692	0.039	70.414	30.273
O²A/O²D		0.028	0.072	0.022	0.006	0.086	0.567	0.077	0.019

** Significant at 1 per cent level

Table 2. General combining ability effects of parents

Genotypes	Productive tillers per plant	Filled grains per ear	100 grain weight	Grain yield per plant	Leaf area index	Total chlorophyii content	Total drymatter accumulation	Harvest index
Lines	-0.53*	4.76**	-0.02	-0.80**	0.32**	0.13**	0.08	0.89*
PMS 98	(8.5)	(82.92)	(1.93)	(17.80)	(4.23)	(1.65)	(44.05)	(36.41)
PMS 10B	0.14	-7.14**	-0.04*	-1.39**	0.14	0.8	-1.04	-2.48
	(8.1)	(94.20)	(1.95)	(19.3)	(4.35)	(1.65)	(47.40)	(39.19)
V 20B	-1.16**	-6.39**	0.06**	-0.97**	-0.46**	-0.15**	-2.42*	0.56
	(10.8)	(116.64)	(2.25)	(20.0)	(4.45)	(1.66)	(45.65)	(40.07)
IR 58025B	-0.7**	2.99	0.01	2.54	0.03	-0.23	2.71**	1.62
	(10.5)	(122.31)	(1.68)	(21.5)	(4.89)	(1.67)	(50.35)	(36.95)
IR 62829B	2.29**	-2.29	-0.02	0.61*	-0.04	0.17**	0.83	1.20**
	(9.8)	(111.23)	(1.96)	(19.0)	(3.93)	(1.53)	(45.60)	(30.00)
SE								
Testers								
BR 736-20-3-1	0.33	-3.96*	0.19**	0.56	-2.02	0.03	0.71	-0.11
	(13.0)	(106.61)	(2.06)	(17.0)	(4.54)	(1.42)	(31.3)	(26.24)
IR 31 406	-0.17	-3.51*	0.00	0.48	0.28**	-0.07**	-1.04	1.83**
	(8.6)	(107.73)	(1.92)	(16.0)	(4.53)	(1.63)	(33.5)	(40.85)
IR 50400-640	-0.85**	-1.29	-0.15**	0.24	0.02	0.08**	-2.21**	-1.88
1-2-2-2	(5.8)	(96.42)	(2.00)	(17.9)	(4.28)	(1.65)	(41.20)	(38.40)
IR 8866-20-3-	-0.45**	8.22**	0.05*	-3.32**	-0.37**	-0.29**	-4.75**	-1.40**
1-4-2	(10.8)	(113.71)	(2.12)	(18.7)	(4.02)	(1.47)	(40.20)	(41.33)
MDU 3	-0.129**	7.04**	0.07**	-3.60**	-0.05	-0.15**	-1.02	-2.84**
(8.3)	(85.20)	(2.06)	(15.20)	(4.22)	(1.38)	((43.40)	(31.22)	
MDU 4	0.89**	1.70	0.03	0.64	0.05	-0.19**	3.69**	-0.72
	(16.50)	(116.61)	(2.12)	(25.4)	(4.57)	(1.69)	(55.40)	(42.63)
Ponni	1.37**	-8.19**	0.06**	5.00**	0.08	0.02	4.60**	5.11**
	(13.0)	(147.00)	(1.96)	(18.4)	(4.22)	(1.40)	(47.00)	(38.09)
SE	0.29	1.48	0.02	0.35	0.10	0.02	0.67	0.44

*Sugnicant 5per cent level; **Significant at 1 per cent level; values in parentheses represent the per se performance of the parents

Table 3. SCA effects and per se performance of selected hybrids for grain yield and other yield component and physiological traits

Hybrids	Productive tillers per plant	Filled grain per ear	100 grain weight	Leaf area index	Total chlorophyii content	Total drymatter accumulation	Harvest index	Grain yield per plant
IR 62829A X 1.05	21.28	-0.02	0.26	0.01	13.67**	6.46**	10.93**	
BR 736-20-3-	16.1	135.8	2.25	5.92	1.64	70.7	45.15	35.0
1								
V 20A X IR	2.02**	2.50	0.13*	1.34**	0.12	17.23**	7.46**	10.83**
50400-64-1-	8.3	114.6	2.14	6.61	1.47	68.1	43.75	33.00
2-2-2								
PMS 10A X	1.368	6.59	-0.12	-0.36	0.06**	5.70**	6.47**	6.59**
Ponni	15.3	118.10	2.00	5.58	1.46	64.70	46.71	33.1
PMS 9A X	5.14**	24.71**	0.01	0.72**	-0.02	6.29**	1.56	5.36**
IR 50400-64	16.20	147.90	1.95	6.77	1.61	59.50	36.79	27.70
1-2-2-2								
PMS 10A X	0.14	-6.30	0.05	-0.02	-0.24**	-0.74	7.59**	5.55**
MDU 4	13.6	115.1	2.14	5.89	1.07	57.4	42.00	27.7
IR 58025A X -2.32*	-1.75	0.53**	0.28	0.09**	8.99**	3.72**	5.20**	
BR 736-20-3-	9.7	117.0	2.83	6.00	1.32	67.9	42.83	31.2
PMS 9A X -2.43**	-9.02**	0.18**		0.13	-0.14	3.68*	4.16**	5.21**
IR 31406	9.2	112.0	2.27	6.43	1.34	58.05	42.70	27.30
IR 58025A X	-1.26	-18.65**	0.01	0.57*	-0.09**	1.77	3.64**	3.76**
MDU 3 10.3	111.1	2.06	6.26	1.05	58.90	40.03	25.60	
PMS 10A X	1.77**	-2.71	0.18**	0.25	0.04*	0.60	3.29**	2.01*
IR 8866-20-	12.90	125.20	2.19	5.74	1.82	50.30	37.01	20.20
1-1-4-2								
IR 58025A X	6.28**	-7.85	-0.03	0.41	-0.06**	-0.46	2.89*	1.58*
IR 31406	17.8	111.4	2.09	5.61	1.06	56.7	43.95	27.5

*Significant at 5%level; **Significant at 1% level; Upper values represent sca effects and lower values represent the per se performance of the hybrids

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