Oryza Vol. 43. No.3, 2006 (241-243)

Genetic evaluation of WA-based CMS and restorer lines for yield and agronomic characters in rice

Yog Raj*[1], M.P. Pandey, D.K. Dwivedi and S.K. Shukla

Department of Genetics & Plant Breeding,G.B. Pant University of Agriculture & Technology, Pantnagar - 263 145, U.S. Nagar, Uttaranchal, India

ABSTRACT

Combining ability studies for grain yield and contributing characters from line × tester mating design involving three stable CMS and 18 well adapted high yielding varieties as the testers showed importance of both additive and non-additive genetic variance with preponderance of the latter in their expression. General combining ability effects indicated CMS IR 46820A as the best combiner followed by ZS 97A and V20A, all being average combiners for grain yield/plant. Among the testers, IR 36 was the best combiner for most characters including grain yield. Based on SCA effects, the most promising were V 20A/Suweon 325R, ZS 97A/UPR 231-28-1-2, IR 46830A/BG 367-4 and V20A/Sarjoo 52 for grain yield. Most of these combinations involved average/good general combiner parents into them and high per se performance and these are suggested for exploitation in hybrid/recombination breeding.

Key words: *CMS line, gene action, hybrid rice, yield components*

Information on inheritance of characters is essential in designing efficient breeding strategy for further genetic improvement of the crop. The choice of CMS and restorer lines, especially for heterosis breeding using WA based CMS as genetic tool becomes much easier and genetically more sound when based on combining ability test and their mean performance. Information on genetics of diverse CMS and newly developed and elite varieties with fertility restoration ability is almost too inadequate. The present investigation therefore, critically evaluate three CMS lines and 18 elite restorer varieties for their potential in combination and recombination breeding for grain yield and other characters. Hybrid progenies (54) from three CMS (V 20A, ZS 97A and IR 46830A) and restorers (Table 1) crossed in line × testers mating design were evaluated with parents in the RBD with two replications. Each entry was grown in a single row plot with 15 plants spaced 20 cm between row and 20 cm between plants within a row. The observations were recorded on five competitive plants per plot selected at random from each treatment for ten characters (Table 1). Days to 50 % flowering was taken on the whole plot basis. Plot means were subjected to combining ability analysis as suggested by Kempthorne (1957).

The analysis of variance revealed highly significant variances due to hybrids and line × tester interaction, GCA and SCA for all the ten characters, indicating the presence of adequate variability and importance of both the additive and non-additive gene actions in their expression. However, the ratio of GCA/ SCA indicated preponderance of non-additive genetic variances in their inheritance.

The estimates of GCA effects of the CMS lines and restorers (Table 1) showed IR 46830A to be the best general combiner for plant height, panicle number plant^{-1} and flag leaf length. V 20A was the good general combiner for harvest index and average combiner for seven characters. The results suggested exploitation of this line in combination breeding. Among the testers, IR 36 was the best general combiner with GCA effects for the maximum of five characters including grain yield plant^{-1} and harvest index. The testers Suweon 325R,

[1]**Present address :** *HRI Ltd., Hyderabad, Andhra Pradesh, India*

Table 1. Estimates of general combining ability effects of parents for various characters

Line/testers	Days to 50 % flowering	Plant height	Panicle number plant^{-1}	Panicle length	Flag leaf length	Spikelet number panicle^{-1}	Spikelet fertility	Total dry matter plant^{-1}	Harvest index	Grain yield plant^{-1}
Lines (Cytoplasmic male sterile)										
V 20A	0.45	1.61**	-3.19**	0.27	1.22	2.50	-0.29	-2.02	3.71**	1.16
ZS 97A	-0.88	2.58**	0.22	0.73**	0.98	-4.62	5.41**	2.28	0.11	0.26
IR 46830A	0.44	-4.20**	2.97**	-1.01**	-2.20**	2.04	-5.11**	-0.25	-3.82**	-1.43
SE(gi)	0.38	0.31	0.96	0.23	0.66	0.02	0.76	2.31	0.72	1.23
Tester (Restorers)										
Narendra 118	-10.50**	-15.61**	5.22*	-1.69**	-6.67**	-41.78**	5.52**	-13.83**	-0.24	-6.79-
Kasturi	10.16**	10.98**	-5.15*	2.45**	4.47**	22.70*	-61.92**	-13.65*	-25.29**	-21.39**
UPRI 79-11	5.50**	4.73**	-2.35	0.61	0.26	32.71**	14.92**	8.62	4.88**	5.98
N 22	-2.00*	-0.75	1.89	-0.77	-5.22**	-11.12	-19.69**	-11.13*	-8.75**	-10.70**
Rasi	-3.66**	-4.33**	-2.40	-2.49**	-2.77	13.37	-17.22**	-16.66**	-4.91**	-10.78**
Govind	-2.66**	0.02	1.80	-0.74	2.21	-20.78*	7.22**	-3.46	5.51**	2.64
IR 36	-4.16**	2.78**	-0.25	1.20*	0.19	-12.28	14.20**	5.06	8.60**	8.63**
UPR 79-123	5.16**	1.64*	-0.17	1.84**	6.84**	3.62	16.37**	10.79	0.01	4.25
BG 367-4	3.33**	4.13**	1.37	-0.57	0.54	-1.78	-31.29**	4.99	119.00**	-13.02**
Pant Dhan 4	4.66**	-5.56**	-2.01	-1.89**	1.54	-3.95	-35.67**	-23.42**	-11.59**	-16.82**
Sarjoo 52	-0.33	-2.81**	4.10	-0.37	3.89*	-7.95	17.50**	17.26**	-3.45	5.55
Pusa 205R	-2.66**	1.48	-1.09	-0.09	1.565	15.37	10.40**	0.04	5.08**	3.16
Suweon 294R	-3.50**	6.59**	-0.57	0.29	-3.97*	17.04	16.05**	-10.20	5.39**	-3.11
Suweon 325R	3.16**	-1.88*	2.77	-0.97	-2.52	-5.12	19.95**	28.93**	6.70**	19.22***
Manhar	-0.16	0.36	-0.21	1.39	2.44	-2.12	-7.74**	-1.34	-4.42*	-2.62
Pusa 702R	-4.66	-5.68**	1.74	1.02	-1.20	-2.12	17.69**	2.21*	13.56**	7.88*
Suweon 332R	-0.33	-0.02	-*0.51	0.75	14.25**	14.37	21.07**	14.23*	18.08**	21.49**
UPRI 231-28-1-2	3.66**	3.76**	-4.19	0.04	2.34	-2.95	13.42**	1.56	9.84**	6.42*
SE(gi)	0.93	2.05	2.35	0.56	1.61	9.48	1.87	5.66	1.77	3.02

Suweon 332R and Pusa 702R were identified as good general combiners for some very important characters. Similarly, Dwivedi *et al*. (1999) also reported higher GCA effects for yield and yield contributing traits.

As regards SCA, eight of 54 hybrids recorded significant and positive effects for grain yield (Table 2). The maximum SCA effects were expressed for V20A/Suweon 325R followed by ZS 97A/UPRI 321-28-1-2, IR 46830A/BG 364-4 and V 20A/Sarjoo 52. The hybrid V 20A/ Suweon 325R also showed high SCA effect for total dry matter plant^{-1} which was primarily due to its high SCA effects for longer maturity duration, optimum plant height and higher effective tiller number plant^{-1}. Almost similar trend was observed for other hybrids with high SCA effects for grain yield. Predominant role of non additive gene effects for grain and its components have been reported (Verma *et al*., 1995; Singh and Kumar, 2004). It was most explicit that the cross combinations manifesting high SCA effects for grain yield also invariably exhibited high and positive SCA effects for some yield related traits and as such while selecting the best specific combination for yield, it would be important to give due weightage to yield related traits. Grafius (1959) suggested that there are no separate genes for *per se*, but yield is an end product of multiplicative interaction among various yield components. In view of this, it appears that heterosis for yield may be through heterosis for individual yield components or alternatively, due to multiplicative effects of non-addtive gene effects of component characters.

Perusal of data on top eight hybrids showing the highest SCA effects and *per se* for grain yield (Table 2) indicated their higher SCA effects from crosses with parents having GCA average/high (V 20A/Suweon 325R, ZS 97A/UPR 231-28-1-2 and IR 46830A/IR 36), average/poor (IR 46830/BG 367-4 and ZS 97A/N 22) as also reported by others (Dwivedi *et al.*, 1999; Bisne and Motiramani, 2005). Superior SCA of former group of crosses is due to interaction of positive alleles between parents and the high yielding ability would be fixable and therefore, have potential not only for exploitation in heterosis but also recombination breeding to isolate superior lines with prospects of fertility restorer genes for WA based CMS system. The crosses with good or average/poor combining parents, the high yield potential was attributed to interaction between positive alleles from good or average combiner and negative alleles from the poor combiner and the higher yield would not be fixable. Therefore, such crosses are exploitable for heterosis breeding which is feasible option as the female parent involved were stable CMS lines.

Table 2. Estimate of specific combining ability effects, heterobeltiosis (%), *per se* performance and general combining ability of parents of top eight hybrids for grain yield and other characters

Hybrids	Days to 50 % flowering	Plant height	Panicle number plant^{-1}	Panicle length	Flag leaf length	Spikelet number panicle^{-1}	Spikelet fertility	Total dry matter plant^{-1}	Harvest index	Grain yield plant^{-1}	***per se*** perfor-mance	Hetero-beltiosis	GCA of parents #
V 20A/Suweon 325R	18.0**	4.1**	5.0	1.8	1.6	5.6	-2.1	68.0**	6.1	31.8**	86.0*	134.7*	A/G
ZS 97A/UPR 231-28-1-2R	-3.6*	14.1**	10.1**	2.0*	1.1	35.1*	-7.1*	35.4**	-2.9	20.4**	60.9	66.3**	A/G
IR 46830A/BG 367-4R	-10.6**	-9.0**	-1.5	-1.9	-8.7**	-44.7**	55.6**	7.7*	28.3**	16.7**	36.0	-1.6	A/P
V 20A/Sarjoo 52R	8.5**	10.2**	-4.6	2.6*	7.0*	37.9*	9.6**	13.4	7.3*	14.5**	94.9*	49.9*	A/A
ZS 97A/Manhar R	-2.2	5.7**	-1.6	1.7	4.2	5.8	17.2*	20.6*	6.0	13.9**	45.3	23.6	A/A
IR 46830A/IR 36R	-1.1	-6.9**	3.6	-0.5	-33.4**	3.3	1.3	15.4*	7.5**	13.0*	53.4	45.9*	A/G
ZS 97A/N 22R	5.5**	31.0**	-9.1*	-1.8	-3.6	25.8	28.9**	5.2	15.0**	12.4**	35.8	-2.3	A/P
IR 46830A/UPR 79-123R	5.0**	7.2**	-2.0	-0.3	2.2	29.6	3.6	27.2**	-0.4	10.6*	47.2	28.9	A/A

* and ** significant at P = 0.05 and 0.01, respectively and # A = average, G = good and P = poor

REFERENCES

Dwivedi DK, Pandey MP, Pandey SK and Rongbai Li 1999. Combining ability over environments in rice involving *indica* and tropical *japonica* lines. Oryza, 36: 101-107

Grafius JE 1959. Heterosis in barley. Agron J, 5: 551-554

Kempthorne O 1957. An introduction to genetic statistics. John Wiley and Sons, Inc, New York. p.151

Singh NK and Kumar Anand 2004. Combining ability analysis to identify suitable parents for heterotic rice hybrid breeding – IRRN 29(1) : 21-22

Verma YS, Singh H and Pandey MP 1995. Combining ability for yield and its components in rice. *Oryza*, 32: 01-05

Bisne R and Motiramani NK 2005. Identification of maintainers and restorers using WA some cytoplasmic male sterile lines in rice. IRRN, 30 (2) : 14-15