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Studies on combining ability and heterosis in rice

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Abstract: Based on *per se* performance, combining ability effects and genetic distance, the genotypes *viz.* ASD 20, CO 43, CR 1009, IET 15431, CB(DH) 95298 and TNAU 841434 were identified a best contributers for grain yield and other yield contributing characters. The genotypes HA 891037 was early flowering in duration and had short plant stature. Additive gene action was found in the hybrids *viz.* CR 1009/AS 95035, CR 1009/IET 15341, CR 1009/CB(DH) 95298, CR 1009/IS 14 and CR 1009/ASD 20. Among the hybrids, CR 1009/HA 891037, CR 1009/TNAU 841434, ADT 40/AS 95035, CO 43/ADT 43, CO 43/AS 95035, Improved White Ponni/IET 15341, Improved White Ponni/CB 97033 and Improved White Ponni/CB (DH) 95298 were selected as most promising hybrids based on, *per se* performance, *sca* effect and heterosis. These hybrids with non additive gene action can be used for exploitation of heterosis.

Key words : Combining ability, Heterosis, Rice genotypes.

Introduction

Rice is the world's most important food. More than half of the world's population depends on rice for calories and protein, especially in developing countries. The world population particularly that of the rice consuming countries is increasing at a faster rate. By the year 2025, about 758 million tonnes of paddy which is 70 per cent more than the current production will be needed to meet the growing demand (Duwayri *et al.* 1999). Crop improvement in rice depends on the magnitude of genetic variability and the extent to which the desirable genes are heritable. A critical survey of the genetic variability, correct understanding of the gene effects and knowledge on the extent of heritability of these traits would help in planning an efffctive breeding programme. Combining ability and heterosis are thus, excellent tools which help discern the goal and direction in a breeding programme.

Materials and Methods

The material used in the present study consisted of fourteen varieties (short, medium and long duration) of *indica* rice (*Oryza sativa* L.). All the fourteen parents were raised thrice at an interval of 15 days to ensure synchronization in flowering for the purpose of hybridization in the field during *rabi* 1998 at Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore. Forty hybrids were produced by crossing four lines (CR 1009, ADT 40, C 43 and Improved White Ponni) with ten teste (ADT 43, ASD 20, HA 891037, IS 14, / 95035, CB 97033, CB (DH) 95298, ACK 19 IET 15341 and TNAU 841434). Seeds fro 40 cross combinations along with fourteen parent were raised in randomized block design wi 3 replications in two seasons. A spacing o 20 x 20 cm and a fertilizer dose of 120 60: 60 NPK kg/ha was given and uniform practies were adopted. Each hybrid was raise in 1.8 m x 0.6 m plot size. All the biometrica observations were recorded as before and a maturity stage. The mean values recorded fo the seven characters in parents and F1 generatior were used for statistical analysis. The combining ability analysis was carried out as per the method described by Kempthorne (1957). The mean values were used to estimate heterosis per cent under three categories (Fonesca and Patterson, 1968). The analysis was done using the INDOSTAT statistical package.

Results and Discussion

Among the lines, CO 43 recorded the highest tiller number, dwarf plants and higher grain yield. ADT 40 had high mean for 100 grain weight and longer duration. Its *gca* effecet was high and positive for grain yield, number of filled grains per panicle, panicle length and negative for plant height. Higher *gca* effect was observed for grain yield, 100 grain weight number of tillers in CR 1009 (Table 1). ıra *et al.* (1991) and Ganesan (1995) also rted high *gca* effect for grain weight and ı yield. Mean performance was high for cle length and number of filled grains per cle in Improved White Ponni. These parents ld be successfully utilised in varietal ovement programmes.

Among the testers parents, ASD 20 recorded er grain yield. Earlier duration was observed IA 891037 which also recorded negative effects for days to 50 per cent flowering. genotype IET 15341 recorded more number roductive tillers, lengthy panicles and high tive *gca* effect for grain yield. For number illed grains per panicle, higher mean value observed in CB (DH) 95298 followed by ΛU 841434. These parents also showed high *gca* effects indicating the possible additive gene action for these traits.

Among the hybrids, CR 1009/HA 891037, CR 1009/TNAU 841434, CO 43/ADT 43, Improved White Ponni/IET 15341, ADT 40/AS 95035 and Improved White Ponni/CB (DH) 95298 recorded higher mean grain yield and also had high *sca* effects. Most of these hybrids had also recorded higher positive heterosis for grain yield. In some of the above hybrids, it was observed that, parents having high mean, high *gca* effect produced hybrids with superior characters (Table 2). The parents of the two hybrids CR 1009/AS 95035 and CR 1009/IET 15341 were good general combiners and desirable mean for grain yield. These hybrids recorded significant heterosis for grain yield but had significantly negative *sca* effects. These hybrids may be

e **1.** Best lines and testers based on *per se* performance and *gca* effects

ɔ.	Characters	Line Mean	Tester *gca* effect	Mean	*gca* effect
	Days to 50% flowering	ADT 40 I.W.Ponni CO 43	I.W.Ponni ADT 40 CR 1009	HA 891037 ADT 43 ASD 20	HA 891037 ASD 20 ACK 198
	Plant height	CO 43 CR 1009 ADT 40	CO 43 CR 1009 ADT 40	AS 95035 HA 891037 IS 14	CB 97033 CB (DH) 95298 ASD 20
	Number of productive tillers per plant	CO 43 I.W.Ponni CR 1009	CO 43 I.W.Ponni	AS 95035 CB (DH) 95298	IET 15341 CB (DH) 95298
	Panicle length	I.W.Ponni ADT 40 CR 1009	CO 43 CR 1009 ADT 40	IET 15341 TNAU 841434 CB 97033	ACK 198 ADT 43 AS 95035
	Number of filled grains per panicle	I.W.Ponni ADT 40 CO 43	CO 43 CR 1009 I.W.Ponni	CB (DH) 95298 TNAU 841434 ACK 198	TNAU 841434 IET 15341 ACK 198
	100 grain weight	ADT 40 CR 1009 CO 43	CR 1009 ADT 40 CO 43	ACK 198 TNAU 84143 IS 14	HA 891037 IS 14 IET 15341
	Grain yield per plant	CO 43 CR 1009 ADT 40	CR 1009 CO 43 ADT 40	ASD 20 IET 15341 ACK 198	IET 154341 TNAU 841434 AS 95035

Table 2. Superior hybrids based on *per se* performance, *sca* effects and average (di), better (dii) and standard (diii) heterosis for gain yield

Hybrids	*Per se* performance	*sca* effect	Heterosis		
			di	dii	diii
CR 1009/ADT 43	41.87	-0.381	58.04**	50.51**	49.17**
CR 1009/HA 891037	57.98	18.077**	177.10**	108.45**	106.59**
CR 1009/CB (DH) 95298	38.87	-3.077*	65.80**	39.72**	38.48**
CR 1009/IET 15341	40.13	-4.864*	41.15**	38.15**	42.99**
CR 1009/TNAU 841434	50.77	8.453*	94.51**	82.50**	80.88**
ADT 40/ADT 43	43.25	5.216**	63.93**	56.70**	54.10**
ADT 40AS 95035	45.43	6.541	89.97**	64.61**	61.88**
ADT 40/CB (DH) 95298	38.98	1.253	67.07**	41.24**	38.90**
ADT 40/TNAU 841434	41.20	3.099*	58.51**	49.28**	46.79**
CO 43/ADT 43	48.32	9.003**	81.53**	72.15**	72.15**
CO 43/ASD 20	42.17	8.169**	46.54**	43.02**	50.24**
CO 43/IS 14	41.40	4.648**	64.45**	47.51**	47.51**
CO 43AS 95035	44.60	4.427**	84.68**	58.91**	58.91**
CO 43/ACK 198	38.58	2.532	45.23**	37.47**	37.47**
CO 43/IET 15341	40.72	-1.347	42.57**	40.16**	45.07**
I.W.Ponni/IET 15341	46.97	10.779**	66.84**	61.68**	67.34**

* Significant at 5% level; ** Significant at 1% level

an ideal source for varietal development programme. If these hybrids are utilized in pedigree breeding, there is a possibility of isolating high yielding genotypes. Besides these hybrids, three other best hybrids namely CR 1009/CB (DH) 95298, CR 1009/IS 14 and CR 1009/ASD 20 recorded significant negative *sca* effects along with desirable *per se* performance and significant heterosis. They are the product from one good and one poor combining parents. These hybrids in their segregating generations may throw transgressive segregants. To obtain desirable early segregants the appropriate breeding method would be biparental or reciprocal recurrent selection method as reported by Wilfred Manual and Palanisamy (1989).

Hybrids involving the parent HA 891037 showed high negative heterosis for earliness irrespective of the female parent, indicating the possibility for exploiting early duration in its hybrids involving these parents. Only a few hybrids recorded negative relative heterosis and heterobeltiosis for plant height in pooled data analysis. Hybrids showing lower mean plant height involved parents with low *per se* and low *gca* effects. Heterosis in the hybrids involving low x low *gca* (high negative *gca*) might have resulted from recessive x recessive gene interaction. Such hybrid combinations can be used in breeding programmes for deriving dwarf lines in their progenies. The hybrids CR 1009/ASD 20, ADT 40/CB (DH) 95298 and CO 43/ADT 43 recorded higher values of heterosis (mid, better parent and relative) for numebr of productive tillers. These hybrids also had high *per se* performance and high *sca*. High *gca* values recorded by their parents also indicated the presence of additive gene action in the crosses. Number of filled grains per panicle and 100 grain weight were more in CR 1009/HA 891037 and CO 43/ADT 43 over mid parent and better parental value in pooled analysis. The superiority of the hybrids involving CO 43 was probably due to its good combining ability for most of the yield attributing characters indicating the possible additive gene action. For early duration, the hybrids CR 1009/HA 891037 and

0 43/ACK 198 were found to be promising. In the cross CR 1009/HA 891037 the 100 grain weight and number of filled grains per panicle recorded higher values. It also recorded high *sca* and heterosis for these traits indicating hybrids between the lines and testers with good general combining ability for yield and its component characters would yield high heterotic hybrids (Dhaliwal and Sharma, 1990; Ramalingam *et al.* 1993 and Ganesan and Rangaswamy, 1998). Medium stature plant type was observed in the hybrid involving CR 1009 and CB 97033. This hybrid had parents with negative *gca* effect for plant height. Presence of high negative *sca* effect of this hybrid indicated the additive gene action for this trait as reported by Manonmani and Ranganathan (1998). In such a case, random mating or cyclic breeding is to be adopted to obtain desirable segregants and selection may be postponed to later generations. The above hybrid combinations were selected based on the norms *viz.* high mean performance, high *sca* effect and high heterotic value as indicated by Singh and Hari Singh (1983).

Presence of non additive gene action for grain yield and most of the yield components in the hybrids resulted in high amount of vigour in F_1 indicating the possibility of augmenting yield by exploiting heterosis. Reciprocal recurrent selection to accumulate the favourable genes will be useful to exploit this type of gene action (Kalaimani and Kadambavana Sundaram, 1988). From this studies, it was inferred that most of the traits are governed by non additive gene action. The most appropriate breeding technique to exploit this type of gene action will be through heterosis breeding. Apart from this, a breeding strategy like doubled haploid production through anther culture technique can be recommended. The hybrids which showed additive gene action for different traits can be improved by pedigree breeding and selection can be postponed to later generations.

References

Dhaliwal, T.S. and Sharma, H.L. (1990). Combining ability and maternal effects for agronomic and grain characters in rice. *Oryza*, **27**: 122-128.

Duwayri, M., Tran, D.V. and Nguyen, V.N. (1999). Reflections on yield gaps in rice production. *Intl. Rice Comm. Newslett.* **48**: 13-25.

Fonesca, S. and Patterson, F.L. (1968). Hybrid vigour in a seven parent diallel cross in common winter wheat. *Crop Sci.* **8**: 85-88.

Ganesan, K.N. (1995). Cytoplasmic differences of CMS lines in heterosis breeding of rice (*Oryza sativa* L.) M.Sc.(Ag.) Thesis, submitted to the Tamil Nadu Agricultural University, Coimbatore-641 003.

Ganesan, K.N. and Rangaswamy, M. (1998). Combining ability studies in rice hybrids involving wild abortive (WA) and *Oryza perennis* sources of CMS lines. *Oryza*, **35**: 113-117.

Kalaimani, S. and Kadambavana Sundaram, M. (1988). Genetic analysis in rice. *Madras Agric. J.* **74**: 369-372.

Kempthorne, O. (1957). An introduction to genetic studies. John Wiley and Sons, New York.

Manonmani, S. and Ranganathan, T.B. (1998). Genetic analysis in early lines of *indica* rice. *Oryza*, **35**: 358-360.

Mishra, S.B., Mishra, C.H. and Chaubey, C.N. (1991). Combining ability of some cultivars with selected cytoplasmic male sterile (CMS) lines. *Int. Rice Res. Newsl.* **16**: 6.

Ramalingam, J., Vivekanandan, P. and Vanniarajan, C. (1993). Combining ability in lowland early rice. *Crop Res.* **6**: 228-233.

Singh and Hari Singh (1983). Combining ability and heterosis for seed yield, its component characteristics and *indica* mustard sown early and late. *Indian J. Agric. Sci.* **55**: 309-315.

Wilfred Manual, W. and Palanisamy, S. (1989). Line x tester analysis for combining ability in rice. *Oryza*, **29**: 15-18.

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