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STUDY OF HETEROSIS IN RELATION TO COMBINING ABILITY AND *per se* PERFORMANCE IN RAINFED RICE

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A Study was made of the heterosis in relation to combining ability and *per se* performance for yield and six compenent traits in the varietal hybrids obtained in a diallel cross of 12 varieties observed for all characters. The highest heterosis of 165 per cent was observed for productive tillers followed by penicle weight, grains per panicle, plant yield, 1000 seed weight and days for first flowering for earlines. Heterosis for yield was mostly due to simultaneous heterosis for productive tillers, panicle weight and giains per panicle. There was a variable relationship between heterosis and combining ability effects. In general s. c. a. and g. c. a. had a pronounced effect on hetetosis either singly or in association with each other. Hybrids with high heterotic response were mostly found with high *per se* performance and vice versa. The possibility of growing hybrid rice with attendant heterosis for yield, productive tillers' panicle weight and grains per panicle was discussed.

The importance of hybrid vigour as a means for further improvement in yield in rice has often been stressed by different workers (Chang *et al.*, 1971; Huang, 1970; Saini and Kumar, 1973) and in the context of an yield plateau already reached, heterosis breeding in rice has assumed significance. Heterosis has resulted in substantial yield increase and at the same time in a stable performance even under adverse conditions of growth (Swaminathan *et al.*, 1971). The possibility of ratooning the hybrids planted in low lying and tail-and areas with problems of water stagnation would enlarge the scope for the use of hybrids in such of those specified locations (Sree Rangaswamy, 1982). Expression of heterosis in the form of an increased number of grains per panicle, productive tillers and panicle weight in addition to good grain filling would be of immense value in increasing the production of rainfed/Semi-dry rice faced with the problem of moisture stress conditions. High heterosis manifest in F 1 hybrids is the basis for a successful programme, of evolving hybrids. The present investigation deals with the measurement of heterosis and its relations to combinining ability effects and *per se* performance in different crosses of rainfed rice varieties.

MATERIALS AND METHODS

The material consisted of twelve varieties of rainfed rice-IR 8608, IR-4722, B-733 C, IR-8073 and IR-45 (early duration varieties), Kattanur, Kuruvai Kalangiam, Kaika, KMP-34, IR-6228, IR-8103 and IR-13564 (medium duration varieties) and their 132 hybrids obtained in a diallel. All the parents and hybrids were grown in a randomised block design with two replications in 1982 summer season in the Multi-Crop Experiment

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Station, Paramakudi. Each plot consisted of a single row of ten plants with a spacing of 60 X 30 cm. Observations were recorded on five random plants on days for first flowering (x_1), plant height (x_2), productive tillers per plant (x_3), grains per panicle (x_4) plant yield (x_5), panicle weight (x_6), and 1000 seed weight (x_7) Analysis of combining ability was done according to Method - I Model - II of Griffing (1956). Heterotic effects were expressed as per centage increase or decrease over better (high) parent (Heterobeltiosis), mid-parent (Significant heterosis), and the standard variety TKM-9 (standard heterosis).

RESULTS AND DISSCUSSION

A range of heterosis over mid-parent, better parent and standard variety TKM-9 was observed in varietal hybrids of rainfed rice for yield and other yield components under study. The expression of heterosis varied with the crosses as also characters. The highest significant heterosis of 165 per cent was observed for productive tillers followed by panicle weight (133%), grains per panicle (127%), plant yield (126%), plant height (47%), 1000 seed weight (46%), and days for first flowering (10%), (Table-1). Remarkable positive heterosis for grains per panicle followed by plant height. earliness, grain weight and yield in irrigated rice has been observed and reported by different workers (Amirtha Devarathinam, 1982; Karunakaran. 1968; Paramasivam, 1979; Renganatham *et al.*, 1973; Siva Subramanian and Madhava Menon, 1973; Swaminathan *et al.*, 1971; Viramani *et al.*, 1981). An analysis of the hybrids with particular reference to heterobeltiosis revealed a good number of them to be superior in performance to their respective better parents, besides mid-parent and the standard variety for each of the yield character, and this would signify the role of dominance and epitasis in the expression of heterosis (Table-1). Both additive and non-additive type of gene adtion was found important in the expression of yield and its components in rainfed rice.

Most of the hybrids flowered earlier than their early parents. There were also instances of the hybrids flowering later than late parents but with no significant effects duration. Among the earlier,the hybrid 6x7 exhibited significant heterosis of 50 percent over mid-parent for earliness. Four other crosses viz. 8 x 5 (-33%), 1 x 3 (-25%), 3 x 2 (-32%) and 2 x 6 (-22%) also manifested heterosis for earliness and of these, 1 x 3 was the earliest showing heterobeltiosis value of-30 percent and standared heterosis value of-5 percent. As regards plant height. It was found that the varietal crosses were mostly intermediate in height to be classified into either semi-dwarf, medium tall or tall types. Many hybrids were medium tall types, which, with high grain yield would meet the dual purposes of straw and increased production in rainfed rice culture.

As many as 13 crosses showed positive standard heterosis for yield and all other six yield components. Besides 19 other crosses that were heterotic for yield also showed simultaneous heterosis for productive tillers, grains per panicle and panicle weight.

High heterosis for yield was mostly due to high heterosis accompanied in productive tillers, panicle weight and grains per panicle.

High heterosis observed simultaneously for yield and yield characters particularly panicle weight, productive tillers and grains per panicle, would be worthy of consideration to be exploited by growing hybrids as a rainfed crop of rice culture. As in any other dryland crop, it would hardly be ever possible to have an optimum plant population under circumstances of moisture stress conditions caused by frequent failures of the monsoon rains or adverse seasonal conditions with the end result of an uneven stand with gaps. a very common feature in rainfed crops. It is quite a common practice to resort to gap filling by using culms separated out from the main clump. Heterosis expresed for an increased number of tillers would serve the purposes of gap-filling with extra seedlings in form of culms, also found with high potential for further tillering in a short period (Jeganathan and Mukerjee, 1983), gathered from out of the main clumps by separation. Reports are available to the effect that yield was directly corrlated with grains per panicle and panicle weight in rainfed rice. High heterosis observed for these two characters would increase the chances for obtaining an increased yield.

On the scrutiny of the best five hybrids selected on the basis heterotic response over superior parent and high *per se* performance for yield, panicle weight, 1000 seed weight, grains per panicle and productive tillers, it was found that the effects of s. c a. was pronounced in the expression of heterosis evident from the crosses 12 x 1 and 8 x 7 for plant yield, 7 x 11, 3 x 7 and 4 x 11 for 1000 seed weight, 9x5, 7 x 5 and 2 x 10 for grains per panicle and 5 x 4 for productive tillers. The effect of dominance of genes was thus apparent in the expression of heterosis. The dominance effects of genes was also found fortified by high g. c. a. effects as it would be seen from the crosses 12 x 1, 8x2 for panicle weight and 7 x 11, 3 x 7 and 4 x 11 for 1000 seed weight, indicating additive and additive x additive type of gene action in addition to dominance of alleless in the expression of heterosis. It was also the high g. c a. effect shown by any one of the parents in cross combinations such as 11x6 for plant yield, 1x7 and 8x7 for grains per panicle, that was mainly responsible for high heterosis. High heterosis brought about by epistatic type of gene action was evident in crosses, particularly 5x6, 10x3, 2x4 and 4x10 for productive tillers even in the obsence of any significant g c. a. High Heterotic crosses were not always obtained between high general combiners but obtained between low general combiners also. A combination of two good general combiners was not necessarily the best cross combination and low x low combination, a poor one.

The best five crosses indentified on the basis of heterobeltiosis were not always the corresponding five top rank hybrids with high *per se* performance. Of the 25 hybrids, only nine, 1 for plant yield, 2 for panicle weight, 2 for 1000 seed weight, 3 for grains per panicle and 2 for productive tillers, occupied positions in both the categories of best 5 hybrids, but with

Table 1. Estimates of heterosis for yield and six yield components in Varietal hybrids of rainfed rice.

	Days first flowering	Plant height (cm)	No. of productive tillers	No. of grains per panicle	Plant yield (g)	Panicle weight (g)	1000 seed weight (g)
	X_1	X_3	X_8	X_4	X_5	X_6	X_7
Range of							
Significant heterosis	—50to10	—45to48	—56to165	—56to127	—70to126	—76to133	—33to46
Heterobeltiosis	—30to 7	—48to32	—94to150	—94to 98	—81to122	—81to104	—39to56
Standard Heterosis	— 5to42	—16to56	—67to100	—35to160	—42to148	—62to 77	—30to37
No. of hybrids superior to							
Mid parent	25	41	83	44	62	53	41
Better parent	8	20	70	30	42	35	25
Standard variety	130	97	100	104	96	55	66

Table 2. Best five crosses of rainfed rice on the basis of heterobeltiosis and *per se* performance for yield and four yield components.

Cross	Parentage	High heterosis					High *per se* performance		
		h	m	s	gi	gj	Cross	m	h
Plant yield									
11 x 7	IR-45/IR-6228*	120	93	5.3	5.5**	-3.5**	8 x 9	99	71
11 x 6	IR-45/IR-8103	109	83	16.3	5.5**	-3.2**	1 x 9	97	68
12 x 1	KMP-34/IR-8608	97	76	20·8*	-4.9*	1.1	11 x 7	93	120
6 x 12	IR-8103/KMP-34	91	67	0.1	-3.2	4.9**	1 x 11	88	122
8 x 7	K. Kalingiam/IR-6228	77	78	20.7*	-1.1	3.5**	5 x 4	81	-33
Panicle weight									
12 x 1	KMP-34/IR-8608*	104	3.3	0.9*	0.1	5.7**	4 x 2	3.5	-43
1 x 7	IR-8608/K. Kalangiam	80	2.2	0.4	5.7**	0.3	4 x 1	3.4	-45
1 x 11	IR.8608/IR-45	76	2.8	0.6	5.7**	4.3	12 x 1	3.3	104
8 x 2	K. Kalangiam/IR-4722*	62	3.2	0.7*	6.5**	-2.0	8 x 2	3.2	62
8 x 7	K. Kalangiam/IR-6228	64	2.4	4.2	6.5**	-0.3	3 x 10	3.3	35
1000 seed weight									
7 x 11	IR-8608/IR-45*	32	29.4	1.5**	0.5**	-0.5**	3 x 7	30.9	18
2 x 6	IR-4722/IR-8103	19	1.3	0.1	-0.4**	-0.4**	8 x 2	29 7	-5
3 x 7	Kattanur/IR-6228*	18	30.9	0.9*	1.2**	0.5**	2 x 3	29 6	13
4 x 11	IR-13564/IR-45	17	28.0	1.1**	0.6**	-0.5**	7 x 11	29.4	32
8 x 9	K. Kalangiam/IR-8072	15	26.6	0.4	2.0**	-0.8**	4 x 10	28.2	13
Grains per panicle									
9 x 5	IR-8072/B-733C*	45	325	83.1**	-4.4	5.7	9 x 5	325	98
4 x 10	IR-13564/Kaika*	41	257	1.3	20.3	-2.5	6 x 8	284	38
7 x 5	IR-6228/B-733*	31	245	33.1**	6.2	5.7	4 x 10	257	41
4 x 11	IR-13564/IR-45	23	225	14.8	20.3	-14.5**	4 x 3	251	18
2 x 10	IR-4722/Kaika	23	218	24.6**	-1.1	-2.5	7 x 5	245	31

Cross	Parentage	High heterosis h	m	s	gi	gj	High *per se* performance Cross	m	h
Productive tillers:-									
5 x 6	B-733C/IR-8103	150	31	0.4	0.2	0.2	5 x 4	50	50
10 x 6	Kaika/B-733C	123*	41	6.0	-0.5	0.2	5 x 10	47	61
2 x 4	IR-4722/IR-13564	77	33	0.2	0.3	0.3	9 x 3	42	36
5 x 4	B-733C/IA-13564	72*	50	11.1	0.2	9.3	11 x 6	41	42
4 x 10	IR-13564/Kaika	70	32	5.6	9.6	-0.5	10 x 6	41	123

m = mean s = s. c. e. h = heterosis per cent g = g. c. e.

different ranking in each. In general, the rank hybrids with high *per se* performance were mostly heterotic and the crosses with high heterotic response were found with high *per se* performance. However, certain crosses, viz. 5x4 for plant yield and 4x12 and 4x1 for panicle weight to be mentioned as those noted for high *per se* performance, were conspicuous by the absence of heterotic response. Similarly the hybrids of the crosses 6x12 for plant yield and 1x7 for panicle weight with a significant heterobeltiosis value of 91 and 80 respectively, were found with comparatively poor *per se* performance, (Table 2). It was obvious from the above that there were possibilities for getting a cross with high *per se* performance but with low heterosis and high heterotic effect but with poor *per se* performance, necessitating thereby judicious care and attention in the choice of hybrids to be chosen for high heterosis or high *per se* performance, the latter, considered in terms of merits would very much be desired.

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