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ESTIMATION OF HETEROSIS IN CROSSES INVOLVING SALINE RESISTANT RICE CULTURES

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To evolve suitable saline and alkaline resistant rice strains for southern districts of Tamil Nadu, hybridization was done between susceptible high yielders and resistant donor parents. Crossed seeds obtained were sown in the nursery beds along with their respective parents. Metric traits were recorded and studied in randomly selected 20 hybrids. Heterosis, heterobeltiosis and standard heterosis were computed. Among the 15 cross combinations studied, four cross combinations viz., TKM 6 (M) x Cul. 7583, TKM 6 (M) x Cul. 7609, IR 26 x Dasal and IR 29 x Cul. 7609 expressed high vigour and yield potential.

The present trend in rice breeding is oriented towards evolution of rice strains suitable for problem areas. In such a programme, the saline and alkaline resistance assumes an important role. In southern districts viz. Madurai, Ramanathapuram, Thirunelveli and Kanyakumari considerable area is under saline and alkaline condition. It becomes essential to evolve saline and alkaline resistant rice strains suitable to the southern districts of Tamil Nadu. Hence hybridization programme was launched on a large scale recently at the Agricultural College and Research Institute, Madurai.

MATERIALS AND MATHODS

Seeds of six high yielding susceptible varieties viz., IR 20, IR 26, IR 28, IR 29, IR 30 and TKM 6 (M) and six resistant donors viz, C 75, Cul. 7583, Bilekagga-36, Gettu, Dasal and Cul. 7609 were received from the Paddy Breeding Station, Coimbatore.

Three sowings in the nursery beds were taken up with an interval of ten days to achieve synchronisation in flowering. Seedlings were transplanted in the main field with 30 cm between rows and 30 cm between plants in the row. Emasculation was carried out by "wet cloth" method and pollinated with resistant donor parents. The panicle was covered with butter paper bag to prevent cross pollination. Crossed seeds were collected, dried and sown in the nursery beds along with their respective parents. Seedling of hybrids and their respective parents were transplanted in the main field with a spacing of 30 cm between rows and 20 cm between plants in the row adopting randomized block design replicated twice. The row length was five meters.

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Table 1a Mean Performance of parents

S. No.	Parents	Height (cm)	Tiller number	Panicle length (cm)	Number of spikelets	100 grain weight (g)	Grain yield per plant (g)
1.	Cul. 7583	79.41	19.28	18.22	118.80	1.696	5.40
2.	IR 30	75.12	31.86	20.46	141.40	1.630	11.80
3.	C 75	132.04	26.71	24.64	146.00	2.516	12.60
4.	Bilekagga-36	115.64	18.71	20.06	184.00	2.487	5.40
5.	Gettu	104.57	20.00	18.50	103.25	1.540	4.20
6.	IR 29	76.72	30.14	19.16	106.60	1.424	3.60
7.	IR 26	80.24	28.57	23.10	248.00	2.100	13.80
8.	Dasal	88.84	19.57	19.10	132.40	1.969	4.40
9.	Cul. 7609	86.77	14.71	20.43	168.25	1.426	1.60
10.	IR 28	117.24	19.29	20.76	98.00	2.459	4.00
11.	IR 20	98.17	32.00	26.43	248.00	1.696	18.80
12.	TKM 6 (M)	74.20	24.29	18.86	167.00	1.876	4.80

The metric characters viz., plant height, number of productive tillers, primary panicle length, number of spikelets per panicle, 100 grain weight and grain yield per plant were recorded in randomly selected twenty plants in each replication and in each cross and parent. The mean values were computed and presented in Tables 1a and 1b.

Data were analysed statistically adopting the methods suggested by Panse and Sukhatme (1957). The significance was tested by means of Fisher's 't' test. The heterosis observed in hybrids were estimated using three criteria viz., (di) increase/decrease over mid-parental value, (dii) heterobeltiosis - increase / decrease over better parent and (diii) standard heterosis - increase/decrease over the superior parent

RESULTS AND DISCUSSION

PLANT HEIGHT

Among the fifteen cross combinations studied, five expressed positive and significant results for plant height of which the maximum heterosis of 92.79 per cent was recorded by TKM 6 (M) x Cul 7583 over mid parent (di). This finding

is in agreement with the observations of Dhulappanavar (1967), Capinpin and Punyasingh (1938) and IRRI (1964, 1965 and 1966). Three crosses viz., TKM 6 (M) x Cul 7583, IR 29 x Cul 7583 and IR 26 x Gettu exhibited positive and highly significant heterosis of 92.79, 48.72 and 37 92% over mid-parent; 72.01, 21.93 and 17.26% over better parent (dii-heterobeltiosis) and 30.30, 14 30 and 4.54% respectively over the best parent (diii-standard heterosis) as shown in Table 1b. Reduction in height in many cases could be due to dominant expression of the dwarfing gene present in the varieties.

NUMBER OF PRODUCTIVE TILLERS

Maximum number of productive tillers (42.00) was observed in the cross, TKM 6 (M) x Cul 7583. Positive, highly significant and maximum increase of 92 79% over mid-parent 72 01% over better parent and 30 30% over the superior parent were evident. This finding is in line with the result of Misro and Sastri (1962) and work carried out at IRRI, Philippines (IRRI 1963 and 1965). Three cross combinations viz., TKM 6 (M) x Cul 7583, IR 29 x Cul. 7583 and IR 26 x Gettu recorded positive and highly significant heterosis for the three parameters studied for number of productive tillers. Besides, TKM 6 (M) x Cul. 7609 and IR 26 x Bilekagga-36 recorded positive and significant heterosis over mid parent and over better parent for tiller number.

PANICLE LENGTH

Maximum heterosis of +8.40% over mid parent and +4.26% over better parent for panicle length was recorded by TKM 6 (M) x Cul. 7609 (Table 1b). However, the increase was not substantial. On the other hand, reduction in panicle length was pronounced in all other cross combinations compared to the superior parent. This finding is in conformity with the results of Misro and Sastri (1962), work carried out at IRRI, Phillippines (IRRI 1963 and 1965), Karunakaran *et al*. (1964) and Rajagopalan *et al*., (1973).

NUMBER OF SPIKELETS PER PANICLE

Considerable negative heterosis was observed in all cross combinations for number of spikelet per panicle over all the three parameters except the cross IR 26 x Dasal and IR 29 x Cul 7609 which recorded + 7.25 and +25.52% respectively over mid parent as presented in Table 1b. Negative heterosis was more pronounced when comparad to better parent. The maximum heterotic effect of -68.54% was observed in cross, IR 20 x Dasal when compared to mid-parental value. This is in agreement with the work of Rajagopalan *et al*, (1973). The maximum significant heterotic effect of -117.05 per cent was recorded by IR 29 x Dasal over better parent for number of spikelet

Table. 1b Percentage of heterosis over mid-parent, better parent and superior parent in economic traits of rice hybrids

S. No.	Cross	PLANT HEIGHT (Cm) F_1	di	dii	diii	TILLER NUMBER F_1	di	dii	diii	PANICLE LENGTH (Cm) F_1	di	dii	dii
1.	IR 29 x Dasal	83.49	+ 0.86	— 6.02	—36.89	25.50	+ 2.57	—15.39	—19.69	19.06	+ 2.25	— 0.53	—27.85
2.	IR 26 x Cul 7583	97.62	+22.28	+21.66	—26.15	18.63	—22.21	—34.79	—40.51	10.04	— 7.84	—17.57	—27.93
3.	IR 26 x C 75	101.52	— 4.35	—31.26	—23.13	22.67	—52.41	—20.65	—28.26	20.68	— 9.17	—16.07	—21.73
4.	TKM 6(M) x Cul. 7609	100.10	+24.36	+15.36	—24.27	28.75	+47.43**	+18.36**	+ 9.84**	21.30	+ 8.49	+ 4.26	—19.39
5.	IR 30 x Cul. 7583	74.30	— 5.14	— 6.43	—43.88	24.00	— 3.07	—24.67	—24.24	17.79	— 8.01	—13.05	—32.65
6.	IR 8 x Dasal	86.30	—16.25	—18.02	—34.76	16 00	—17.65	—18.24	—48.48	19.20	— 1.20	— 7.51	—27.32
7.	IR 30 x Cul. 7609	106.30	+31.32	—22.51	—19.56	11.00	—52.70**	—65.47**	—63.63**	20.40	+ 6.47	— 0.29	—22.79
8	IR 26 x Dasal	97.30	+15.90	+ 9.52	—26.40	36.00	+49.56	+26.00	+12.12	20.53	— 0.34	—11.12	—22.30
9.	TKM 6(M) x Cul. 7583	90.00	+17.19	+25.93	—31.15	42.00	+92.79**	+72.01**	+30.30**	19.40	+ 4.43	+ 2.86	—26.57
10.	IR 20 x Dasal	89.21	— 4.59	— 9.13	—32.55	28.66	+11.19	—10.43	—10.12	17.67	— 9.05	—33.07	—33.11
11.	IR 26 x Bilekagga-36	116.83	+19.29	+ 1.03	—11.48	31.00	+31.13*	+ 7.84*	— 3.03*	19.53	— 9.50	—15.45	—25.70
12.	IR 29 x Cul. 7683	73.75	— 5.53	— 8.39	—44.30	36.75	+48.72**	+21.93**	+14.39**	19.98	+ 6.41	— 2.35	—24.38
13.	IR 20 x C 75	101.70	—11.64	—23.74	—23.05	33.00	+12.40	+ 3.13	+ 3 03	12.80	—43.21	—51.57	—13.72
14.	IR 26 x Gettu	107.30	+16.13	+ 2.71	—18.80	33.50	+37.92**	+17.26**	+ 4.54**	18.90	— 9.13	—18.18	—28.46
15.	IR 29 x Cul. 7609	87.50	+ 7.03	+ 0.95	—33.85	25.02	+11.55	—20.46	— 6 98	17 90	— 9.64	—12.38	—32.24
	CD at 5% level		22.04	25.45	25.45		5.51	6.37	6.37		32.48	37.50	37.50
	CD at 1% level		29.79	34.41	34.41		7.45	8.61	8.61		43 91	50.69	50 69

Table 1b Continued

		NUMBER OF SPIKELET PER PANICLE				100 GRAIN WEIGHT				GRAIN YIELN PER PLANT			
		F_1	di	dii	diii	F_1	di	dii	diii	F_1	di	dii	dii
1.	IR 29 x Dasal	61.00	—49.04*	—117.05*	—77.80*	2.193	— 0.18	— 9 52	—12.839	8.42	+110 50**	+91.36**	—49.96**
2.	IR 26 x Cul. 7583	140.42	—23 43	— 76.71	—43.03	1.874	+34.04	—10.76	—25.520	7.10	— 26.04*	—48.55	—62.24
3.	IR 26 x C 75	149.17	—24.28*	— 66.25	—39.53	2.007	—13.22	—20.23	—20.232	14.00	+ 6.06	+ 1.44	—25.54
4.	TKM 6(M) x Cul. 7609	97.50	—41.84**	— 42.05**	—60.20**	1.921	+16.35	+ 2.39	—23.651	4.75	+ 48.43	— 1.04	—74.75
5.	IR 30 x Cul. 7583	75.80	—41.74*	— 46.39*	—68.88*	1.938	+16.35	+12.61	—22.896	5.00	— 41.86	—57.62	—73.42
6.	IR 28 x Dasal	85.00	—26.21	— 35.80	—65.20	2.036	— 8.03	—17.20	—19.080	5.00	— 19.04	+ 1.36	—73.42
7.	IR 30 x Cul. 7609	75.00	—51.56**	— 55.42	—68.20**	1.723	+12.76	—29.93	—31.522	2.00	— 17.14**	—83.05**	—83.38**
8.	IR 26 x Dasal	204.00	— 7.25	— 17.42	—17.60	2.002	— 1.62	— 4.66	—20.432	22.17	+143.62**	+75.14**	+17.93**
9.	TKM 6(M) x Cul. 7583	135 00	— 5.53	— 19.16	—45.20	1.734	— 2.91	+ 7.56	—31.085	7.50	+ 47.05*	+38.88	—60.12
10	IR 20 x Dasal	59.83	—68.54**	— 75.61**	—75.26**	1.550	—15.43	—21.27	—38 399	2.00	—82.75**	—89.36**	—89.38**
11.	IR 26 x Bolikagga 39	68.00	—68.52**	— 72.58**	—72.00**	2.060	—10.20	—17.16	—18.126	7.66	— 20.20	—44.49	—59.80
12.	IR 29 x Cul. 7583	86.25	—23.47	— 27.40	—64.74	1.457	—29.27	—39.89	—42.095	3.75	— 16.66	—30.55	—80.07
13.	IR 20 x C 75	140.00	—28.93*	— 43.55*	—43.20*	2.019	— 4.13	—19.75	—19.756	5.50	— 64.96**	+ 1.85**	—70.76**
14.	IR 26 x Gattu	93.50	—46.76**	— 62.30**	—61.80**	1.679	— 7.74	—20.00	—33.270	14.50	+ 61.11**	+ 5.07**	—22.88**
15.	IR 29 x Cul. 7609	172.80	—25.52	+ 2.53	—30.20	1.970	+ 2 22*	—18.72	—21.704	10.00	+284.61**	+177.77**	—46.82**
	CD at 5% level		43.50	50.23	50.23		0.532	0.620	0 820		2.385	2.775	2.76
	CD at 1% level		58.80	67.89	67.89		0.720	0.830	0.830		3.224	3.724	3.73

(di) : increase/decrease over mid-parental value; dii : (heterobeltiosis) - increase/decrease over better parent
(diii) : (standard heterosis) - increase/decrease over superior parent ; * : Significant at 5% level; ** : Significant at 1% level.

per panicle

100 GRAIN WEIGHT

Eight cross combinations expressed negative and significant heterosis for the three parameters Only one cross, IR 29 x Cul. 7609, recorded positive and significant heterotic value of 2.22 per cent over mid-parent for 100 grain weight. Five crosses recorded positive heterotic effect over mid-parent, the maximum was 34.04% (IR 26 x Cul. 7583) and the minimum was 2.22% (IR 29 x Cul. 7609). Three crosses viz., TKM 6 (M) x Cul. 7609, IR 30 x Cul. 7583 and TKM 6 (M) x CUL. 7583 recorded positive heterosis of 2.39, 12.61 and 7.56% respectively over better parent for 100 grain weight. Negative heterosis over better parent was observed in all crosses for 100 grain weight.

GRAIN YIELD PER PLANT

Heterosis for yield of grains per plant was evident in many of the cross combinations, the maximum recorded in the cross IR 29 x Cul. 7609 when compared to mid-parental value and better parental value This result is in accordance with the work of Parnell *et al.*, (1922), Gorai (1968), Narayanan Namboodhri (1963) and Sukanya Subramanian *et al.*, (1973). Five cross combinations recorded positive and significant values over mid-parent for grain yield per plant, the maximum being 284.61% (IR 29xCul. 7609) and the minimum 47.05% (TKM 6 (M) x Cul. 7583). Five crosses exhibited positive and significant results over better parent of which the cross IR 29xCul. 7609 recorded the maximum heterosis of 177.77% and the minimum of 1.85% recorded by IR 20 x C 75. Only one cross viz., IR 26 x Dasal expressed highly significant and positive heterotic value of 17.93% over superior parent for grain yield per plant. This is the only cross which exhibited positive and highly significant heterotic value for the three parameters (Table 1b). Four crosses viz., IR 9 x Dasal, IR 26 x Dasal, TKM 6 (M) x Cul. 7583 and IR 29 x Cul. 7609 recorded positive and significant heterotic values over mid parent and over better parent for grain yield per plant. This result is in accordance with the work of Sukanya Subramanian *et al.* (1973).

The yield increase was more only in the cross, IR 26 x Dasal. when compared to the superior parent. This is in conformity with work at IRRI (1963). The increase in yield of grain in the cross, IR 26 x Dasal was probably due to the heterotic effect observed in productive tiller number and number of spikelets per panicle. On an overall consideration of the expression of heterosis in different cross combinations, it could be observed that there may be considerable dishormony between the gene combinations leading to

the negative heterosis in most of the cases.

On an overall consideration, the crosses TKM 6 (M) x Cul. 7583, TKM 6 (M) x Cul 7609, IR 26 x Dasal and IR 29 x Cul. 7609 showed better combination to induce vigour and yield potential. Therefore, it is suggested that these crosses may be exploited further to derive useful segregants.

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