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Prediction of Hybrid Vigour for Yield Attributes among Synthesized Hybrids in Rice (*Oryza sativa* L.)

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Abstract: Five cytoplasmic male sterile lines and ten testers of diverse origin were crossed in Line. Tester fashion to obtain 50 hybrid combinations. The performance of the hybrids was estimated based on relative heterosis, heterobeltiosis and standard heterosis with ASD 16 as check for seed yield and its contributing characters. Many of the hybrids, IR 688886A/ ADT 41, IR 688897A / ADT 41, IR 688886A / ASD 19, IR 68885A / ASD 16 and IR 58025A / ACK 03002 exhibited significantly negative heterobeltiosis as well as standard heterosis for days to flowering and maturity indicating the possibility of exploiting heterosis for earliness. The best hybrid was IR 68885A / White ponni, which showed standard heterosis and heterobeltiosis for panicle length, spikelets per panicle, grains per panicle, straw yield and grain yield. Relative heterosis for grain yield per plant ranged between -69.17 to 243.21 coupled with significant heterobeltiosis from -75.71 to 219.75. The standard heterosis ranged from -73.71 to 129.16 for grain yield per plant. Based on *per se* performance and standard heterosis the hybrids IR 68885A / White ponni, IR 688886A / White ponni, IR 688886A / ADT 41 and IR 58025A / CO 43 were identified as the superior hybrids for the characters of panicle length, grains per panicle and grain yield. Hence, these rice hybrids may be used for commercial cultivation.

Key words: Cytoplasmic male sterility, relative heterosis, heterobeltiosis, standard heterosis, Rice.

INTRODUCTION

Rice is life and princes among the cereals and is the stable food in areas of high population density and fast population growth. The total production is 535 million tonnes of unmilled, rough rice with average productivity of 3.7 tonnes per hectare. By the year 2025, about 756 million tonnes of paddy, which is seventy percent, more than the current production will be needed to meet the growing demand[1]. The succcess of hybrid rice programme depends upon the magnitude of heterosis which also helps in the identification of potential cross combinations to be used in the conventional breeding programmes to create wide array of variability in the segregating generations. A good hybrids should manifest high heterosis for commercial exploitation.

MATERIALS AND METHODS

The present investigation on rice was conducted at Agricultural College and Research Institute, Killikulam during December 2003. Using five CMS lines *viz.,* IR 58025A, IR 62829A, IR 68885A, IR 688886A, IR 688897A and ten testers *viz.,* ACK 03002, ADT 39, ADT 41, ADT 42, ADT 43, ASD 16, ASD 18, CO 43, ASD 19 and White ponni were crossed in a line ´ tester mating design, fifty hybrids combinations were obtained. The F_1s along with the parents were raised in Randomized Block Design with three replications. For each entry, fifteen plants were transplanted in a row of 2m length in each replications with 20 ´ 10 cm spacing with single seedling per hill. Observations on days to flowering, plant height, panicles per plant, panicle length, spikelets per panicle, grains per panicle, straw yield and grain yield were recorded on five samples and mean values were used for statistical analysis. Heterosis was expressed as percentage increase or decrease of F_1 as heterosis over mid parent (average heterosis), over better parent (heterobeltiosis) and over standard check variety ASD 16 (standard heterosis), Shull[8].

RESULTS AND DISCUSSIONS

The prime objective of hybrid programme is to converge the desirable genes from the parent on to a single genetic background. Scope for exploitation of hybrid vigor will depend upon *per se* performance of hybrid and magnitude of heterosis. Magnitude of heterosis was estimated over mid parent, better parent and standard parent. Each one has its own importance in genetic analysis. The real performance of a hybrid can not be predicted based on relative heterosis and heterobeltiosis. A hybrid is commercially valuable only when it exhibits significantly high standard heterosis over best locally adopted variety. Standard heterosis is also a reflection of *per se* performance. Swaminathan *et al*.,[12] and Siddiq[9] also emphasized the need for computing heterosis over standard variety.

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Table 1: Mean performance of selected hybrids for various yield characters.

Crosses	Days to flowering	Plant height	Panicles per plant	Panicle length	Spikelets per panicle	Grains per panicle	Straw yield	Grain yield
IR 58025A / ADT 39	81.6	93.71	16.8	23.7	146.4	144.2	47.8	43.8
IR 58025A / ADT 43	84.6	102.44	28.5	24.7	125.8	110.8	68.3	75.1
IR 58025A /White Ponni	83.6	100.31	28.6	24.0	131.9	98.6	36.0	43.7
IR 58025A / CO 43	85.3	102.25	24.8	26.1	179.9	153.3	63.1	82.8
IR 58025A / ADT 41	85.6	112.51	31.3	25.6	181.1	177.6	91.6	92.7
IR 62829A / ADT 39	89.6	96.59	17.7	24.6	166.2	118.1	37.5	25.8
IR 62829A /ADT 42	85.0	97.67	25.2	21.9	103.8	69.0	25.8	31.9
IR 62829A /ADT 43	86.0	93.40	21.7	21.8	86.5	63.6	52.3	53.2
IR 62829A /ASD 16	86.6	98.40	27.8	21.8	121.5	76.8	21.2	19.9
IR 62829A /ASD 18	85.0	85.50	20.4	22.4	90.9	38.3	25.3	12.1
IR 68885A /ACK03002	85.3	120.9	27.7	22.2	68.7	35.2	108.9	22.8
IR 68885A /ADT 41	85.3	93.9	32.2	22.1	83.2	51.8	51.3	12.5
IR 68885A /ADT 42	83.3	92.9	18.6	24.3	112.6	62.3	67.6	14.1
IR 68885A /ASD 16	81.0	99.9	27.0	22.0	157.6	79.0	38.2	32.4
IR 68885A /ASD 19	84.6	106.2	35.6	20.8	125.9	84.4	41.7	31.5
IR 688886A /ADT 39	82.6	102.5	24.6	22.1	124.0	92.2	17.4	25.7
IR 688886A /ADT 41	80.6	97.0	23.9	27.3	121.0	117.6	29.2	28.6
IR 688886A /ADT 42	83.0	100.3	23.3	24.7	167.0	125.0	48.1	41.5
IR 688886A /ASD 16	81.6	97.2	32.7	23.4	167.0	128.7	52.3	35.5
IR 688886A /ASD 19	81.0	114.7	20.4	22.6	77.9	64.5	51.5	25.9
IR 688897A / ADT 41	81.0	96.2	33.6	23.0	136.0	92.0	31.8	27.4
IR 688897A /ADT 43	83.0	97.6	36.7	25.1	101.2	90.6	54.5	33.2
IR 688897A /ASD 16	84.3	104.0	26.1	24.4	132.6	110.8	39.8	39.6
IR 688897A /ASD 18	82.3	96.0	22.9	24.4	141.8	107.7	29.2	47.4
IR 688897A /ASD 19	84.0	108.4	52.0	23.6	145.3	117.1	35.9	32.6

The mean and standard heterosis of hybrids based on grain yield and its components are presented in Table 1 and Table 2 respectively. Among the fifty hybrids, 23 and 34 hybrids exhibited earlier flowering and plant height respectively and 21 hybrids recorded positive significant for panicles per plant. Out of fifty hybrids, 25 and 23 hybrids recorded positive significant for spikelets per panicle and grains per panicle respectively. High values for straw yield and grain yield was exhibited by 25 and 19 hybrids respectively. Mean performance of top hybrids for various yield contributing traits viz., days to flowering, plant height, panicles per plant, panicle length, spikelets per panicle, grains per panicle, straw yield and grain yield were selected. The hybrids, IR 58025A / CO 43 and IR 58025A / ADT 41 recorded positive significant for spikelets per panicle, grains per panicle, straw yield and grain yield.

Shorter plant type is an important character of hybrid to withstand lodging. In the present study, fourty eight hybrids exhibited negative standard heterosis for plant height. This might be due to dwarf nature of parental lines especially CMS lines, used in the development of these hybrids. IR 62829A / ASD 18 recorded negative heterosis for plant height. Plant height may not have significant role in the expression of hybrid vigor[2]. Days to 50 % percent flowering are important characters for improvement of

Table 2: Estimates of standard heterosis for yield contributing traits and yield

Hybrids	Days to flowering	Plant height	Panicles per plant	Panicle length	Spikelets per panicle	Grains per panicle	Straw yield	Grain yield
IR 58025A X ACK 03002	-1.163	-18.807**	-11.917**	-30.999**	-63.254**	-61.747**	-60.546**	-73.418**
IR 58025A X ADT 39	-5.039**	-20.944**	-34.715**	-10.442**	-10.000**	-5.502**	-23.534**	8.306**
IR 58025A X ADT 41	-0.388	-5.090**	21.762**	-3.061**	11.302**	16.376**	46.598**	129.169**
IR 58025A X ADT 42	0.000	-16.630**	4.404	-6.789**	-4.224**	-17.904**	-30.817**	32.515**
IR 58025A X ADT 43	-1.550	-13.582**	10.881**	-6.613**	-22.658**	-27.424**	9.384**	85.679**
IR 58025A X ASD 16	0.000	-7.935**	-4.896	-9.208**	-6.272**	-28.079**	-65.089**	-43.309**
IR 58025A X ASD 18	1.163	-21.574**	5.078	-19.788**	-20.364**	-37.773**	-70.559**	-56.213**
IR 58025A X CO 43	-0.775	-13.739**	-3.368	-1.272	10.565**	0.437	1.066	104.895**
IR 58025A X ASD 19	1.163	-6.552**	-4.067	-19.310**	4.912**	-11.747**	-48.443**	7.284**
IR 58025A X White ponni	-2.713	-15.376**	11.140**	-9.132**	-18.930**	-35.415**	-42.312**	8.207**
IR 62829A X ACK 03002	1.550	-13.121**	-48.187**	-12.130**	-32.858**	-35.415**	-73.843**	-46.490**
IR 62829A X ADT 39	4.264**	-18.514**	-31.088**	-6.865**	2.126	-22.620**	-39.891**	-36.025**
IR 62829A X ADT 41	-0.388	-16.799**	-18.135**	-15.984**	-1.028	-26.769**	-50.832**	-11.371**
IR 62829A X ADT 42	-1.163	-17.609**	-2.073	-17.093**	-36.217**	-54.803**	-58.595**	-21.045**
IR 62829A X ADT 43	0.000	-21.202**	-15.544**	-17.471**	-46.827**	-58.293**	-16.283**	31.592**
IR 62829A X ASD 16	0.775	-16.990**	8.290**	-17.546**	-25.321**	-49.651**	-65.963**	-50.692**
IR 62829A X ASD 18	-1.163	-27.861**	-20.725**	-15.229**	-44.124**	-74.891**	-59.490**	-70.089**
IR 62829A X CO 43	5.814**	-22.771**	18.912**	-12.760**	-40.519**	-56.638**	-14.129**	-48.780**
IR 62829A X ASD 19	1.938	-19.015**	6.477**	-19.662**	-6.518**	-44.847**	-56.035**	-43.688**
IR 62829A X White ponni	4.651**	-20.550**	5.440*	-16.085**	-20.323**	-46.681**	-30.668**	-60.102**
IR 68885A X ACK 03002	-0.775	2.047**	7.707**	-15.984**	-57.765**	-76.900**	74.312**	-43.606**
IR 68885A X ADT 39	5.814**	-21.793**	-3.109	-14.800**	-49.654**	-66.987**	-50.405**	-68.490**
IR 68885A X ADT 41	-0.775	-20.747**	25.389**	-16.337**	-48.835**	-66.070**	-17.818**	-68.985**
IR 68885A X ADT 42	-3.101*	-21.557**	-27.720**	-8.124**	-30.769**	-59.170**	8.232**	-65.129**
IR 68885A X ADT 43	-5.426**	-16.175**	-14.767**	-10.669**	-40.150**	-59.389**	-41.405**	-57.564**
IR 68885A X ASD 16	-5.814**	-15.646**	5.181	-16.791**	-3.158*	-48.253**	-38.846**	-19.726**
IR 68885A X ASD 18	0.000	0.987	17.228**	1.398	-2.011	-42.926**	14.854**	22.792**
IR 68885A X CO 43	1.550	-21.242**	-1.036	-7.797**	-4.264**	-52.576**	-16.464**	-28.345**
IR 68885A X ASD 19	-1.550	-10.410**	38.342**	-21.275**	-22.617**	-44.716**	-33.195**	-21.902**
IR 68885A X White ponni	1.938	-16.388**	10.622**	-3.817**	41.698**	41.092**	27.639**	105.405**
IR 688886A X ACK 03002	-1.938	-5.365**	-1.295	-12.987**	-2.995*	-27.336**	4.948**	17.551**
IR 688886A X ADT 39	-3.876**	-13.531**	-4.404	-16.211**	-23.764**	-39.563**	-72.041**	-36.256**
IR 688886A X ADT 41	-6.202**	-18.137**	-6.995**	3.212**	30.310**	-22.969**	-53.167**	-29.202**

Table 2: (Countinue)

Hybrids	Days to flowering	Plant height	Panicles per plant	Panicle length	Spikelets per panicle	Grains per panicle	Straw yield	Grain yield
IR 688886A X ADT 42	-3.488*	-15.353**	-9.326**	-6.537**	2.618*	-18.079**	-23.011**	2.670**
IR 688886A X ADT 43	-1.550	-2.806**	-19.171**	-2.759**	2.782*	-26.070**	-54.137**	-22.660**
IR 688886A X ASD 16	-5.039**	-17.985**	27.202**	-11.349**	2.618*	-15.677**	-16.272**	-12.228**
IR 688886A X ASD 18	-0.775	-19.352**	-4.767	-13.465**	-39.740**	-63.843**	2.111*	-61.371**
IR 688886A X CO 43	4.651**	-19.127**	-2.850	-13.112**	-6.681**	-14.585**	-70.473**	-30.834**
IR 688886A X ASD 19	-5.814**	-3.183**	-20.725**	-14.372**	-52.112**	-57.729**	-17.498**	-35.893**
IR 688886A X White ponni	-5.039**	-22.130**	77.694**	-16.583**	-25.280**	-49.651**	25.123**	-19.661**
IR 688897A X ACK 03002	0.000	-2.188**	94.041**	-10.341**	-49.367**	-38.603**	15.323**	-7.515**
IR 688897A X ADT 39	-0.388	-18.649**	13.472**	-5.026**	7.329**	-42.751**	-4.894**	-33.767**
IR 688897A X ADT 41	-5.814**	-18.835**	30.829**	-13.037**	-16.431**	-39.738**	-49.104**	-32.119**
IR 688897A X ADT 42	0.000	-20.657**	28.238**	-15.304**	-27.328**	-30.087**	-18.469**	-10.498**
IR 688897A X ADT 43	-3.488*	-17.592**	42.746**	-5.101**	-37.774**	-40.611**	-12.700**	-17.914**
IR 688897A X ASD 16	-1.938	-12.255**	1.723	-7.696**	-18.479**	-27.380**	-36.244**	-2.044**
IR 688897A X ASD 18	-4.264**	-18.964**	-10.816**	-7.495**	-12.826**	-29.432**	-53.242**	17.172**
IR 688897A X CO 43	1.163	-19.633**	11.140**	-14.800**	-6.108**	-18.952**	-42.461**	-0.066
IR 688897A X ASD 19	-2.326	-8.481**	102.073**	-10.770**	-10.696**	-23.275**	-42.568**	-19.380**
IR 688897A X White ponni	1.550	-16.445**	20.984**	-5.328**	-34.497**	-45.197**	-20.004**	-34.624**

* Significant at 5% level, ** Significant at 1 % level

yield characters. Heterosis for earliness has been reported by Young and Virmani[14] and Mishra and Pandey[3]. Thirteen hybrids recorded significant negative heterosis for days to flowering. The hybrid IR 688886A / ADT 41 exhibited lower value of days to flowering Significant negative standard heterosis for days to flowering was also indicated by Vishwakarma *et al*.[13] and Patil *et al.*[4].

Number of productive tillers per plant is generally associated with higher productivity. Twenty two hybrids recorded significant positive standard heterosis produced more productive tillers per plant. Among them, IR 688897A / ASD 19 recorded positive significant standard heterosis for panicles per plant. Present observations are in conformity with the findings of Peng and Virmani[6], Singh and Maurya[10] and Seetharamaiah *et al.*[7]. Heterosis for panicle length in general relatively low in all hybrids studies. but only one hybrid recorded positively significant for panicle length. The hybrid IR 688886A / ADT 41 exhibited significantly positive heterosis for panicle length. Lower length of panicles in these hybrids was due to the involvement of male parents with short panicle length. Significant standard heterosis for panicle length was indicated by Sundar[11].

Number of spikelets per panicle and grains per panicle is one of the most important components of yield and probably this character will be helpful in breaking the yield plateau[10]. Small number of hybrids exhibited significant positive standard heterosis for spikelets per panicle and grains per panicle. Longer panicle is generally associated with more number of spikelets. IR 68885A / White ponni recorded positively significant heterosis for spikelets per panicle and grains per panicle. Standard heterosis for straw yield in F1 hybrids depends on the grain character of CMS line. In the present study, the CMS lines IR 688886A, IR 688897A had higher straw yield. Hence, most of the hybrids involving these parents registered significant positive standard heterosis. Ten hybrids recorded positive significant standard heterosis for straw yield.

Patnaik *et al.*,[5] and Mishra and Pandey[3] reported that panicle length, number of filled grains per panicle and 1000 seed weight had contributed for increased grain yield. Selection of hybrids based on *per se* performance and standard heterosis will be more effective to exploit better heterotic hybrids. In the present study, four hybrids IR 68885A / White ponni, IR 688886A / White ponni, IR 688886A / ADT 41 and IR 58025A / CO 43 were identified as the superior hybrids, among the fifty hybrids evaluated. IR 68885A / White ponni was recorded as the best hybrid, since, it possess desirable performance based

Table. 3: Best hybrids selected for based on *per se* performance and standard heterosis

Per se performance	Standard heterosis	Selected hybrids
IR 688886A / White ponni	IR 68885A / White ponni	IR 68885A / White ponni
IR 58025A / CO 43	IR 688886A / ADT 41	IR 688886A / White ponni
IR 68885A / White ponni	IR 688886A / White ponni	IR 688886A / ADT 41
IR 688886A / ADT 41	IR 58025A / ADT 41	IR 58025A / CO 43
IR 688897A / ADT 41	IR 58025A / CO 43	
IR 58025A / ADT 41	IR 58025A / ADT 42	
IR 58025A / ADT 42	IR 688897A / ADT 41	
IR 688886A / ADT 41	IR 62829A / CO 43	
IR 688897A / ADT 42	IR 688897A / ADT 42	

on *per se* and standard heterosis for panicle length, grains per panicle and grain yield. IR 688886A / White ponni had recorded superior performance for days to flowering, plant height and straw yield. IR 688886A / ADT 41 recorded superior performance for grain yield offersscope for commercial exploitation.(Table. 3). Hence, it is obvious that increase in yield in F_1 hybrids is the result of increase in value of yield components. These results suggest that one can expect to develop hybrids from the parents possessing early maturity, semi dwarf height with higher yield.

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