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ASSESSMENT OF HETEROSIS FOR YIELD AND ITS COMPONENTS IN RICE (*ORYZA SATIVA* L.)

Karthikeyan P., S. Ranjith Rajaram*, V. Anbanandan, R. Elangaimannan and P.Satheeshkumar
Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu-608 002

Abstract

The current investigation five rice varieties namely ADT 37, ADT 39, ASD 18, IR 65192-4B-8-1 and IR 6199-3B-24-3 were chosen as parents for the study. Staggered sowing of genotypes was taken. ASD18 x ADT 37(C_1), ADT 37 x ASD 18(C_2), ASD 18 x IR 65192-4B-8-1 (C_3), IR 65192-4B-8-1 x ASD 18 (C_4), ADT 39 x ADT 37 (C_5), ADT 37 x ADT 39 (C_6), ADT 39 x IR 6199-3B-24-3 (C_7), and IR 6199-3B-24-3 x ADT 39 (C_8). Hybridization was carried out by hand emasculation and artificial pollination. Individual crossed seeds were collected on full maturity and pooled cross-wise. The following six traits were studied and observations recorded. Among the five parents studied ADT 39, ADT 37 and IR 6199-3B-24-3 showed high promise for grain yield, more panicle length and more number of grains per panicle. ADT 37 as ovule parent, ADT 39 as pollen parent and IR 6199-3B-24-3 as both ovule and pollen parent contributed much for expression of hybrid vigour for grain yield. The cross ADT 37 x ADT 39 and IR 6199-3B-24-3 x ADT 39 will serve as an ideal cross for heterosis breeding. These two crosses have high *per se* performance and high variability, thereby giving chances for selection of single plants with desirable genotypes and further crop improvement programme.

Keywords: Hybrid breeding, Hybrid vigour, Recombination breeding.

Introduction

Rice (*Oryza sativa* L.) the most important food crop of the globe. Rice breeders are constantly attempting to shift new genotypes with high yield potential to release them as new better yielding varieties than the existing ones. The methodologies like ploidy and mutation breeding have ended in poor results. Hence, the breeders in all the rice growing countries are constantly attempting to refine the pedigree breeding approach through the use of biometrical and genetical analyses. Earlier, rice genetics have been useful to refine the breeding methodology in the rice improvement with these view, an investigation was undertaken to estimate parents and also desirable crosses which would contribute better off-springs for productivity with high breeding value.

Materials and Methods

Experimental Material

Five rice varieties namely ADT 37, ADT 39, ASD 18, IR 65192-4B-8-1 and IR 6199-3B-24-3 were chosen as parents for the study. The experiment was conducted during January-April 2017, Plant Breeding Farm Annamalai University, Annamalainagar.

Methods

Twenty five days old seedlings were transplanted to the main field at the rate of one seedling per hill with the spacing of 30cm between rows and 20cm within plant. Each entry was sown in a row of 4 m, recommended agronomic practices and need based plant protection measures were taken up. Staggered sowing of genotypes was taken for synchronization of flowering. The crosses are ASD18 x ADT 37(C_1), ADT 37 x ASD 18(C_2), ASD 18 x IR 65192-4B-8-1(C_3), IR 65192-4B-8-1 x ASD 18 (C_4), ADT 39 x ADT 37 (C_5), ADT 37 x ADT 39 (C_6), ADT 39 x IR 6199-3B-24-3 (C_7), and IR 6199-3B-24-3 x ADT 39 (C_8). Hybridization was carried out by hand emasculation and artificial pollination. Individual crossed seeds were collected on full maturity and pooled cross-wise. The following six traits were studied and observations recorded. Number of productive tillers per plant, Panicle length (cm), Number of grains per panicle, Number of chaffy grains per panicle, 100 grain weight (g), Plant yield (g).

Results

Mean performance of parents

Among the five parents, IR 65192-4B-8-1 recorded the high *per se* performances for number of productive tillers per plant (10.775). ASD 18 and ADT 39 as well as IR 6199-3B-24-3 and ADT 37 showed less difference among themselves for the productive tillers per plant. There was not much difference in the mean performance of the parents. However, ADT 39 (22.801) and IR 65192-4B-8-1 (20.284 cm) recorded the high and the lowest mean for panicle length respectively. The mean number of grains per panicle was found to be very high (181.944) in ADT 37, followed by ADT 39 with (132.241).

The mean number of chaffy grains per panicle was found to be the low in the parent ASD 18 (12.432) followed by ADT 39 (14.435). The parent, IR 65192-4B-8-1 recorded the high mean number of chaffy grains per panicle (17.896). There were little differences in the mean 100 grain weight, grain weight ranged from 2.141 to 2.434 g, excluded IR 65192-4B-8-1 where the 100 grain weight was very less (1.821 g). Among the parents, ADT 37 recorded the high mean plant yield 23.146 g per plant, followed by ADT 39 with 23.144 g. The mean grain yields of ASD 18 and IR 6199-3B-24-3 were relatively low. The parent IR 65192-4B-8-1 recorded the lowest mean plant yield of 15.375 g per plant (Table 1).

Mean performance of hybrids

The differences among the hybrids were significant for all the traits. The mean values for the different traits are furnished in table 2. The high mean number of productive tillers per plant was recorded by the cross C_3. The lowest mean number of productive tillers per plant was recorded by the cross C_8. The crosses C_2, C_5 and C_7 exhibited significantly increased panicle length over general mean as compared to other cross combinations. The lowest mean panicle length was observed in the cross C_3. The high mean number of grains per panicle of 170.021 was observed in cross C_6. It was superior over other cross combinations studied for this trait. The low mean No. of grains was observed in cross C_4. While the lowest number of chaffy grains per panicle was observed in the cross C_7, The high number of chaffy grains per panicle was recorded in cross C_2.

There were not many differences in the mean of 100 grain weight for the entire cross combinations studied. However the two cross combinations namely, C_2 and C_6 exhibited high 100 grain weight comparatively. The high mean single plant yield of 28.495 g was observed in cross C_6, followed by the crosses C_2 and C_8. The plant yields of these crosses were significantly superior over general mean. The cross combinations involved ADT 39, ADT 37 and IR 6199-3B-24-3 exhibited comparatively high grain yield than the hybrids involving rest of the parents.

Heterosis

Hybrid vigour was estimated for six characters eight cross combinations and expressed in percentage over mid parent (d_i - relative heterosis). For number of productive tillers per plant, the percentage of heterosis ranged between 11.923 (C_8) and 62.262 (C_3). The cross C_3 were exhibited the maximum positive and significant heterosis, followed by cross C_4 with 50.434 percent heterosis. All other cross combinations also exhibited positive heterosis for the trait. Manifestation of high heterosis for number of productive tillers per plant has been reported by Nijaguna and Mahadevappa (1983) and Anandakumar and Sree Rangasamy (1986), Paramasivan (1987) also observed positive heterosis for number of productive tillers. Tsang and Huang (1987) observed negative heterosis for number of productive tillers per plant.

Panicle length (cm) express, positively significant heterosis was observed in majority of the crosses except in C_3 and C_4. The range of heterosis was between -7.843(C_3) and 10.221 (C_2) percent. The heterosis was positively significant for four out of eight crosses namely, C_1, C_2, C_5, and C_6 and negatively significant in two crosses namely, C_3 and C_4. Similar earlier reports on high heterosis were observed by Vivekanandan (1985) and Paramasivan (1987). Number of grain per panicle, four out of eight cross combinations showed positive heterosis with the maximum value of 9.792 per cent in C_7. Rest of the cross combinations had revealed negative heterosis, with C_5 showing significant value. The heterosis were negative in most of the crosses namely, C_1, C_2, C_4 and C_5 studied as reported by Tseng and Huang (1987). However, positive heterosis for this trait was also reported by Singh *et al.,* (1984), Vivekanandan (1985), Kaushik and Sharma (1986) and Paramasivan (1987).

For number of chaffy grains per panicle, Positively significant relative heterosis for this trait was observed in three crosses namely, C_1, C_2 and C_6. The crosses C_3, C_4 and C_5 showed positive value with non significant. For 100 grain weight, the heterosis for the trait ranged from -3.833 (C_1) to 4.211 per cent (C_7). Low and positive heterosis was observed in the majority of crosses. A similar low level of heterosis was reported by Nijaguna and Mahadevappa (1983), whereas high level of heterosis for this trait was observed by Singh *et al.,* (1986), Paramasivan (1987) and Tseng and Huang (1987).

For single plant yield, the percentage of relative heterosis ranged from 3.222 to 22.483. The high heterosis was observed in crosses C_6 (22.483 per cent). All the crosses exhibited positive heterosis with significant values was found in the C_2, C_6, C_7 and C_8 crosses. Similar high level of heterosis for yield was reported by Shrivastava and Seshu (1982), Singh *et al.,* (1984), Anandakumar and Sree Rangasamy (1986), Paramasivan (1987) and Tseng and Huang (1987). However, both positive and negative heterosis for this trait was observed by Nijaguna and Mahadevappa (1983).

Superior performances of F_1 for various traits may be attributed to epistasis or hybrid vigour. Hence, high *per se* may mislead the breeders to having effective selection under pedigree breeding approach. However, such information will also aid in identifying ideal parents for exploiting heterosis for yield improvement. With this view, the results of F_1s detained in this investigation were analyzed for their expression as hybrid vigour to choose the better parent. The crosses C_2, C_6, C_7 and C_8 exhibited hybrid vigour for single plant yield. Specifically, the cross C_6 showed the high heterosis for single plant yield with 22.483 per cent. This cross may serve as good combination for heterosis breeding. The other two crosses namely, C_2 and C_8, recorded the high *per se* performance for grain number, grain yield and also for ear length, they did not show heterosis. These crosses may be relatively desirable for exploitation of pedigree breeding.

Among the five parents studied ADT 39, ADT 37 and IR 6199-3B-24-3 showed high promise for grain yield, more panicle length and more number of grains per panicle. ADT 37 as female parent, ADT 39 as male parent and IR 6199-3B-24-3 as both female and male parent contributed much expression of hybrid vigour for grain yield. The cross ADT 37 x ADT 39 will serve as an ideal cross for heterosis breeding. However, its reciprocal ADT 39 x ADT 37 and also the cross IR 6199-3B-24-3 x ADT 39 may serve as ideal source material for exploitation through pedigree breeding. These two crosses have high mean and high variability, thereby giving chances for selection of single plants with desirable genotypes.

Table 1: Mean performance of parents for six characters

Parents	Number of productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Number of chaffy grains per panicle	100 grain weight (g)	Single plant yield (g)
ASD 18	10.683	21.301	124.902	12.432	2.434	20.482
IR 65192-4B-8-1	10.775	20.384	122.598	17.896	1.821	15.375
IR 6199-3B-24-3	9.784	21.834	123.976	16.582	2.141	20.332
ADT 39	10.314	22.801	132.241	14.435	2.222	23.144
ADT 37	9.283	21.604	181.944	15.974	2.301	23.146
GM	10.168	21.585	137.132	15.464	2.184	20.496
SE	0.521	0.311	7.223	1.972	0.054	0.642
CD	1.642	1.041	24.932	6.642	0.152	2.172

*Significant at P = 0.05 over general mean

Table 2: Mean performance of hybrids for eight cross combinations

Crosses	Number of productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Number of chaffy grains per panicle	100 grain weight (g)	Single plant yield (g)
C_1	13.088	22.007	140.201	19.023	2.255	22.652
C_2	12.024	23.320*	147.523	25.356*	2.362	26.143*
C_3	17.323*	19.211	124.324	19.023	2.158	18.421
C_4	15.712*	19.312	112.201	18.012	2.088	18.424
C_5	12.401	23.311*	141.304	17.021	2.267	24.012
C_6	12.021	23.210*	170.021*	20.680	2.333	28.495*
C_7	13.141	23.034*	141.113	14.021	2.223	24.402
C_8	11.312	22.701	137.143	14.302	2.169	25.921*
GM	13.412	22.013	139.229	18.429	2.232	23.559
SE	0.462	0.313	7.182	1.970	0.050	0.621
CD(0.05)	1.552	1.042	23.941	6.587	0.152	2.087

*Significant at P = 0.05 over general mean

Table 3: Heterosis per cent for eight cross combinations

Crosses	Number of productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Number of chaffy grains per panicle	100 grain weight (g)	Single plant yield (g)
	d_i	d_i	d_i	d_i	d_i	d i
C_1	31.991**	4.164**	-8.442	33.474*	-3.833*	4.341
C_2	18.911*	10.22**	-3.681	78.762**	0.432	20.523**
C_3	62.262**	-7.843**	0.451	19.272	3.353	6.662
C_4	50.434**	-5.254**	-1.352	12.363	0.00	6.083
C_5	23.182**	5.434**	-9.683*	12.544	0.441	3.222
C_6	16.622**	4.893**	8.523	38.093*	3.101	22.483**
C_7	28.102**	2.492	9.792	-7.883	4.211*	11.792**
C_8	11.923*	0.762	6.823	-5.852	1.400	18.682**

*Significant at P = 0.05 **significant at P = 0.01

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