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GENETICS OF RATOONING ABILITY IN RICE *Oryza sativa*

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ABSTRACT

A 6 x 6 diallel analysis involving six rice genotypes *viz., Bhavani,* MDU 3, IET 6262, IET 6709, IET 7552 and IET 9239 showed both general and specific combining ability variances significant for all the characters including ratooning ability. GCA variances were higher than SCA variances for all the traits and indicated the predominance of additive gene action. The parents IET 6709, IET 7552 and *Bhavani* possessed favourable genes for most of the traits and may be combined through recombination breeding to realize high ratoon yield as seen from high mean and significant *gca* effects. The hybrids *Bhavani*/IET 6262, *Bhavani*/IET 6709,IET 6709/IET 7552 and IET 6262/IET 6709 possessed high *per se* performance and *sca* effects for the traits regenerated tiller number, productive tiller number per plant besides ratoon yield and may be exploited in heterosis breeding.

The ability of a rice genotype to ratoon and regenerate new and more productive tillers is a compansatory mechanism to enhance rice productivity. Ratooning capacity is highly varied among the rice genotypes as it is mostly influenced by the gentic factors (Mahadevappa, 1979) for which the rice cultivars are to be evaluated for their combining ability. This assessment will help in proper choice of parents with high ratooning ability besides understanding the genetic architecture on ratooning mechanism in rice. With this view, an experiment was conducted to generate information on genetics of ratooning in rice.

MATERIALS AND METHODS

Six rice genotypes *viz., Bhavani*, MDU 3, IET 6262, IET 6709, IET 7552 and IET 9239 and their 30 hybrids obtained through 6x6 diallel fashion were the materials under study. All the parents and hybrids were raised at the Agricultural College and Research Institute, Madurai, during October, 1988. Thirty day old seedlings were transplanted with 20 x 10 cm spacing in randomised block design, replicated three times. Each entry was represented by two rows of 10 plants. At maturity, the plant crop was harvested 20 cm above the ground level. Ten plants in parents and five plants in hybrids were randomly selected per treatment per replication and observed for the following characters *viz.,* regenerated tiller number per plant,days to 50 per cent flowering, productive tiller per plant, plant height, panicle length, grain number per panicle, 100 grain weight and grain yield per plant. The general and specific combining ability and reciprocal effects were estimated by method I and model I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed that the variances due to general combining ability (GCA), specific combining ability (SCA) and reciprocal effects were significant for all the characters (Table 1). The estimates of GCA mean square were higher than the SCA mean square and ratio of GCA/SCA was more than unity for all the characters studied indicating the preponderance of additive gene action. Hence all the traits under study may be improved by selection through pedigree method of breeding. Ichii and Takayari (1988) reported significant additive as well as non- additive variances for percentage of ratoon tillers and height of ratoon plant.

The success of a breeding programme depends on choice of good parents and the potentiality of the parents are judged by their *per se* performance

Table 1. Estimates of variance for general and specific combining ability

Source	df	Regenerated tiller number/ plant	Days to 50 per cent flowering	Productive tiller number/ plant	Plant height	Panicle length	Grain number/ panicle	100 grain weight	Grain yield/ plant
gca	5	15.72**	168.66**	8.11**	829.09**	23.09**	2577.61**	0.1916**	7.5921**
sca	15	3.08**	1.40**	2.15**	12.83**	0.41**	15.25**	0.0027**	0.42**
rca	15	2.22**	29.96**	1.24**	93.86**	2.61**	1033.13**	0.0636**	3.173**
Error	70	0.08	0.19	0.05	0.88	0.10	0.95	0.0003	0.0014**
GCA/SCA		5.1:1	120.47:1	3.77:1	64.62:1	56.32:1	169.02:1	70.96:1	18.03:1**
$\sigma^2 A$		2.12	27.88	1.22	136.11	3.78	427.14	0.031	1.20**
$\sigma^2 D$		1.74	0.70	1.00	6.94	0.18	8.30	0.001	0.24**

** Significant at 1% level.
gca General combining ability
sca Specific combining ability
rca Reciprocal combiing ability
$\sigma^2 A$ Additive genetic variance
$\sigma^2 D$ Non-additive genetic variance

and *gca* effects (Singh *et al.*, 1985). In the present investigation, the parents IET 6709 and IET 7552 were found to possess more favourable genes for the traits regenerated: tiller number/plant, productive tiller number/plant, panicle length besides ratoon yield as seen from the high mean and *gca* effects (Table 2). However, IET 6709 and IET 7552 had undesirable genes for grain number/panicle and 1000 grain weight respectively due to negatively significant and non-significant *gca* effects. It is interesting to note that *Bhavani* possessed favourable genes for the above traits besides ratoon yield as revelaed by high *per se* and significant *gca* effects.

Kadambavanasundaram (1980) pointed out that the choice of parents based on *gca* effects should be cautiously done since a parent possessing favourable genes for one trait may possess genes governing unfavourable expression for some other traits. Hence by involving the parents IET 6709, IET 7552 and *Bhavani* by recombination breeding, all the ratoon traits may be favourably combined to realize high ratoon yield since the above traits are controlled by additive gene action. Chauhan *et al.*(1987) indicated that high ratooning ability was a recessiive trait and controlled by additive and additive x additive gene effects.

Better hybrids are identified based on high *per se.* performance besides *sca* effects. Among the hybrids, *Bhavani*/IET 6262, *Bhavani*/IET 6709, IET 6709/IET 7552 and IET 6262/IET 6709 registered high *per se* performance (Table 3) coupled with high *sca* effects for the traits regenerated tiller number per plant, productive tiller number per plant besides ratoon yield (Table 4). It revealed the importance of nonadditive gene action for the above traits and also the possibility of utilizing them in heterosis breeding. Further, the hybrids *Bhavani*/IET 6262 and IET 6709/IET 7552 showed significant reciprocal effects for all the characters which reveal the influence of cytoplammic factors. Li Shifen and Chan Tingwen (1986) also reported the material influence of the trait ratoon tiller number/plant. Hence care must be taken in the selection of parents for heterosis breeding. Most of the hybrids identified with high *per se* performance and *sca* effects had either both the parents of atleast one with high *gca* effects. The hybrids *Bhavani*/IET 6262 and IET 7552/IET 9239 showed high *per se* and *gca* effects for ratoon grain yield involving parents with high and low *gca* effects. Richharia and Singh (1983) also suggested that for effective selection, hybrids should be with high *sca* effects, *per se* performance and should have atleast one parent as a good combiner.

In the present study, the magnitude of additive variance was relatively high suggesting that the *per se* performance of parents may be a good indicator of their combining ability. Considering the preponderance of fixable additive gene action for all the characters under study, further improvement for ratooning ability can be effected through pedigree method of breeding. However,

Table 2: Mean and general combining ability (gca) effects of parents

Parents	Regenerated tiller number / plant		Days to 50 per cent flowering		Productive tiller number / plant		Plant height		Panicle length		Grain number / panicle		100 grain weight		grain yield / plant	
	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca
Bhavani	8.7	-0.24**	44.8	2.99**	7.2	-0.28**	78.1	8.45**	17.9	1.33**	77.1	14.81**	1.81	0.05**	14.4	0.62**
MDU 3	7.5	-0.90**	34.7	-3.45**	6.7	-0.63**	49.4	-7.00	12.7	-1.26**	28.5	-10.88**	1.63	-0.07**	12.3	-0.82**
IET 6262	8.9	0.76**	32.7	-2.83**	7.5	0.53**	50.4	-5.65**	14.4	-0.75**	32.6	-10.42**	2.02	0.16**	12.8	-0.16**
IET 6709	10.0	1.45**	45.3	3.19**	8.3	1.13**	69.9	2.75**	17.7	1.28**	41.7	-2.12**	1.78	0.07**	13.7	0.49**
IET 7552	9.1	0.58**	47.2	4.01**	7.8	0.35**	83.1	10.31**	18.3	1.10**	93.1	21.42**	1.36	-0.21	15.1	0.89**
IET 9239	6.4	-1.64**	31.7	-3.90**	5.9	-1.11**	42.6	-8.86**	12.5	-1.69**	24.3	-12.82**	1.72	0.002	11.7	-1.02**
S.E.	0.29	0.08	0.43	0.11	0.22	0.06	0.94	0.25	0.32	0.08	0.98	0.26	0.02	0.005	0.32	0.03
CD (0.05%)	0.81	0.15	1.22	0.23	0.63	0.11	2.65	0.49	0.89	0.22	2.75	0.68	0.05	0.012	0.93	0.08

** Significant at 1% level

Table 3. Mean performance of hybrids

Hybrids	Regenerated tiller number per plant		Days to 50 per cent flowering		Productive tiller number / plant		Plant height (cm)		Panicle length (cm)		Grain number / panicle		100 grain weight (cm)		grain yield / plant (gm)	
	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R
Bhavani/MDU 3	9.1	8.7	42.3	36.8	7.8	7.5	73.0	62.3	18.1	16.0	72.2	36.3	1.78	1.65	14.5	12.5
Bhavani /IET 6262	12.3	10.8	43.5	37.3	10.2	8.9	69.8	61.0	17.3	15.9	65.4	37.1	1.89	2.05	16.1	13.2
Bhavani /IET 6709	11.0	12.7	45.7	46.2	9.3	10.7	77.9	71.4	19.3	18.5	79.6	44.3	1.82	1.86	15.4	15.1
Bhavani /IET 7552	10.1	11.4	45.3	49.5	8.6	9.2	84.6	85.6	19.1	18.5	83.2	97.7	1.75	1.45	14.9	16.3
Bhavani /IET 9239	8.5	8.1	41.3	36.2	7.3	7.5	69.1	58.7	16.8	15.2	68.0	40.4	1.83	1.75	14.3	12.8
MDU 3/IET 6262	10.4	12.3	33.7	32.3	9.0	10.4	51.5	51.0	13.9	14.2	29.9	29.8	1.70	1.92	12.9	13.5
MDU 3/IET 6709	9.8	11.5	37.3	40.5	8.5	9.5	59.9	61.6	16.6	16.9	42.8	32.9	1.74	1.75	13.1	13.7
MDU 3/IET 7552	8.7	10.4	34.3	44.5	7.6	8.8	55.3	74.0	14.5	17.5	33.5	83.1	1.54	1.31	12.4	15.0
MDU 3/IET 9239	8.9	7.5	32.7	32.7	7.8	7.0	50.3	46.9	12.9	13.5	28.6	24.1	1.60	1.69	12.5	10.9
IET 6262/IET 6709	13.1	13.2	39.5	43.3	10.9	11.4	58.1	65.4	16.3	18.5	41.1	40.4	2.13	1.89	14.4	15.2
IET 6262/IET 7552	10.4	12.4	40.0	44.3	8.3	9.9	71.2	76.1	16.4	16.9	36.3	75.3	2.00	1.37	13.0	15.1
IET 6262/IET 9239	10.1	9.3	31.3	33.3	8.6	8.4	48.0	48.1	13.0	14.7	25.1	30.1	1.96	1.74	12.8	12.5
IET 6709/IET 7552	15.3	10.8	45.4	47.8	12.9	11.7	68.4	76.8	17.7	19.1	43.2	102.4	1.71	1.42	15.2	16.8
IET 6709/IET 9239	10.2	9.3	43.0	36.8	8.8	7.9	62.4	59.8	16.3	15.6	33.6	31.5	1.84	1.92	13.5	12.7
IET 7552/IET 9239	10.8	7.9	46.2	34.3	9.1	7.1	78.6	55.2	17.2	14.3	88.3	28.6	1.37	1.70	15.9	12.0
Grand mean	10.6	10.4	40.1	39.7	9.0	9.1	65.2	63.6	16.4	16.4	51.4	48.9	1.78	1.70	14.1	13.8

D - Direct cross; R - Reciprocal cross

Table 4. Estimates of sca and rca effects of hybrids

Hybrids	Regenerated tiller number per plant		Days to 50 per cent flowering		Productive tiller number / plant		Plant height (cm)		Panicle length (cm)		Grain number / panicle		100 grain weight (cm)		grain yield / plant (gm)	
	sca	rca	sca	rca	sca	rca	sca	rca	sca	rca	sca	rca	sca	rca	sca	rca
Bhavani/MDU 3	-0.20	0.23	0.22	2.75**	-0.20	0.23	-0.20	0.23	0.77**	1.09**	0.20	17.93**	0.001	0.065**	-0.15*	0.98*
Bhavani /IET 6262	0.78**	0.73**	0.43	3.08**	0.54**	0.65**	-0.78**	0.73**	-0.19	0.72**	-3.20**	14.15**	0.026*	-0.080	0.36**	1.44*
Bhavani /IET 6709	0.42*	-0.86**	-0.09	-0.25	0.47**	-0.70**	-0.42*	-0.86**	0.07	0.44	-0.80	-17.63**	-0.015	-0.022	0.23**	0.15
Bhavani /IET 7552	0.19	-0.66**	0.59*	-2.08**	0.13	-0.28	0.19	-0.66**	0.18	0.31	4.14**	-7.22**	0.018	0.150**	0.23**	-0.69*
Bhavani /IET 9239	-0.09	0.19	-0.17	2.58**	0.05	-0.10	-0.09	0.19	-0.14	0.83**	2.14**	13.78**	0.002	0.042**	0.06	0.74*
MDU 3/IET 6262	1.23**	-0.96**	-0.55*	0.67*	1.07**	-0.72**	1.25**	-0.96**	-0.16	-0.12	1.06	0.07	-0.009	-0.112**	0.29**	-0.32*
MDU 3/IET 6709	-0.14	-0.84**	-0.64*	-1.58**	-0.25	-0.53**	-0.14	-0.84**	0.48*	-0.17	0.80	-4.94**	0.015	-0.005	-0.15*	-0.31*
MDU 3/IET 7552	-0.40*	-0.86**	-0.96**	-5.08**	-0.28*	-0.58**	-0.40*	-0.86**	-0.06	-1.52**	-2.25**	-24.81**	-0.030**	0.115**	-0.21**	-1.30*
MDU 3/IET 9239	0.47**	0.68**	0.19	0.00	0.42**	0.40*	0.47**	0.68**	-0.06	-0.29	-0.01	2.26**	-0.018	-0.045**	0.17*	0.31*
IET 6262/IET 6709	0.69**	-0.03	1.23**	-1.92**	0.76**	-0.22	0.69**	-0.03	0.64**	-1.13**	3.23**	0.33	0.051**	0.120**	0.62**	-0.43*
IET 6262/IET 7552	-0.20	0.99**	1.16**	-2.17**	-0.52**	-0.83**	-0.20	-0.99**	0.07	-0.22	-5.25**	-19.53**	0.001	0.315**	-0.52**	1.04*
IET 6262/IET 9239	0.34	0.42	-0.77**	-1.00**	0.38**	0.10	0.34	0.41*	0.00	-0.83**	0.82	-2.50**	-0.043**	0.110**	-0.07	0.14
IET 6709/IET 7552	2.53**	0.53*	-0.43	-1.24**	2.13**	0.61**	2.53**	0.53*	-0.20	-0.72**	3.46**	-29.62**	-0.032**	0.145**	0.76**	-0.83*
IET 6709/IET 9239	-0.31	0.47**	0.80**	3.08**	-0.39**	0.46**	-0.31	0.47*	0.10	0.33	-2.60*	1.03	0.073**	-0.038**	-0.27**	-0.41*
IET 7552/IET 9239	0.18	1.43**	0.31	5.92**	0.15	1.00**	0.18	1.43**	0.15	1.44**	-0.29	29.82**	0.005	-1.165**	0.24**	1.93*
SE	0.17	0.20	0.26	0.31	0.13	0.16	0.17	0.20	0.19	0.22	0.59	0.69	0.011	0.012	0.07	0.09
CD (P=0.05)	0.35	0.40	0.52	0.61	0.27	0.32	0.35	0.40	0.38	0.45	1.17	1.38	0.021	0.024	0.14	0.17

* Significant at 5% level; ** Significant at 1% level; sca - specific combining ability effects; rca - reciprocal combining ability effects

non-additive gene action was also found to be significant indicating that the characters are also influenced by dominance and epistatic effect in addition to additive gene action.

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GENETIC DIVERSITY IN PEARL MILLET,*Pennisetum typhoides*

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ABSTRACT

A wide genetic diversity was revealed by the D^2 analysis wherein 41 genotypes of pearl millet *Pennisetum typhoides* (Burm.) S.&H.) fall into as many as fourteen clusters. Based on the average intercluster distances (D), the clusters XIII and XIV were found to be highly divergent from the other clusters. The types P.T.1595 and P.T.834/3 (Cluster XII) were superior for earnumber and grain yield. The types P.T. 928 and P.T. 834/1 (Cluster VIII) were superior for earliness while types P.T. 1611 and P.T. 1620 (Cluster V1) were superior for earlength and straw yield. These types may serve as potential parents for hybridisation programmes.

This investigation was made to study the nature and magnitude of genetic divergence for yield and other important component characters in pearl millet *(Pennisetum typhoides)* (Burm.) S.& H) varieties of diverse origin and to make selection of parents based on the rusults.

MATERIALS AND METHODS

Forty-one genotypes of pearl millet with diverse geographical orgin were chosen from the germplasm bank maintained at the Tamil Nadu, Agricultural University, Coimbatore, for the study. The experiment was laid out in randomised block design with three replications. A spacing 45 X 15 cm. was adopted. Five plants were selected at random in each genotype in each replication. The quantitative diversity of the pearl millet germplasm was estimated by Mahalanobis' D^2 analysis and the results are presented hereunder . For determining the group constellations, a relatively simple criterion was followed.

RESULTS ADN DISCUSSION

Analysis of variances showed significant differences among the types for all characters studies. The plot means of the forty one types for the nine characters were transformed into standardised, uncorrelated mean values and the D^2 values were computed for all possible $\frac{n(n-1)}{2}$=820 pairs of types. The generalised D^2 values arranged from 1.4703 to 289.9321. By the application of clustering technique, the 41 types were grouped into fourteen clusters. The constituent of different clusters with their source are presented in Table1. Among the 14 clusters, clusters IV,VI and VII were the largest having five types followed by cluster V which had four types. The clustering pattern of different types from varying geographical regions was random.

In the present investigation, as many as nine developmental and economic traits were considered. A wide range of variability among the