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Genetic Analysis for Grain Quality Traits in Rice (*Oryza sativa* L.)

D Adilakshmi and P Raghava Reddy
Regional Agricultural Research Station, Maruteru 534 122, West Godavari District, Andhra Pradesh

ABSTRACT

Gene action for grain quality traits in rice were studied in seven parents with early, medium and late duration. Gene action was estimated through Hayman's approach and revealed that both additive and non-additive gene action for traits *viz.,* hulling per cent, head rice recovery, elongation ratio gelatinization temperature, amylose content, protein content . Non-additive gene action (dominant and epistasis) were predominant as compared to additive gene action which is easily transferred through hybridization in crop improvement programme. The positive and negative genes in the parents were distributed unequally for all the traits. Significant values of F for hulling per cent and protein content indicated asymmetrical distribution of dominant and recessive genes in the parents. High heritability in narrow sense was established for head rice recovery, gelatinization temperature, amylose content, iron content and yield per plant. Consequently any selection method adopted could lead to desirable improvement in the above mentioned traits. For varietal improvement Samba mahsuri was the best parent with good cooking quality traits. Vijetha and Indra are the best parents for getting good nutritional quality along with high yields.

Key words : Diallel, Gene action, Genetic components, Rice

Rice grain quality is of great importance for all people involved in production, processing and consumption because it has direct impact on the commercial value of the produce. Consumer preference is based on the appearance, milling, cooking, processing and nutritional quality. Positive visual preference of the grain is based on grain size, shape and chalkiness. Chemical properties of the grain are assessed by analyzing for amylose content (AC) and alkali spreading value (ASV) as they affect the cooking and eating qualities. Volume expansion ratio (VER) and elongation ratio (ER) are the other cooking quality characters which govern consumer acceptability and spread of the variety depends on all these components. Self sufficiency and change in the levels were the main factors which brought a paradigm shift in consumer and market preference for rice with better grain quality. As good grain quality fetches higher returns, quality has become one of the most important objective in rice breeding programme. For improvement of any plant character through hybridization, it is necessary to understand the nature of gene action and genetic architecture of the donor. The diallel analysis useful to understand the characters those can be manipulated for yield improvement of rice.

MATERIAL AND METHODS

Seven rice varieties *viz.,* Samba mahsuri, Polasa prabha, Jagtial samba, Nellore mahsuri, Indra, Vijetha and Prabhat were crossed in diallel mating design (without reciprocals) during *rabi* 2006 and studied during *kharif* 2007 seasons. These parents were selected based on their attributes for grain quality, cooking quality, reaction to pests and diseases and high yield. The parental line Samba mahsuri possessed excellent cooking quality. Polasa prabha, Jagtial samba and Nellore mahsuri have got good grain quality. Indra is having biotic and abiotic stress tolerance like brown plant hopper (BPH) and salinity. Vijetha and Prabhat are high yielding varieties. These varieties showed great diversity for quality traits. The twenty one F_1s and seven parents were grown at the experimental farm of Andhra Pradesh Rice Research Institute and Regional Agricultural Research station, Maruteru, during kharif 2007 in randomized block design (RBD) with three replications having 3m row length and 20x15 cm spacing. Each replication comprised of one row of parent and three rows of F_1 s. Recommended agronomic practices were followed to raise a good a crop. Data were recorded on yield components *viz.,* hulling per cent, milling per cent,

Table 1. Mean of parental varieties for quality traits in rice (Oryza sativa L.)

Variety	Hulling (%)	Milling (%)	Head rice recovery (%)	L/B ratio	Volume expan-sion ratio	Elon-gation ratio	Gelati-nization tem-perature	Amy-lose content (%)	Protein content (%)	Iron (ppm)	Zinc (ppm)	Grain yield per plant (g)
	1	2	3	4	5	6	7	8	9	10	11	12
Samba mahsuri	74.99	64.91	57.96	2.89	3.97	1.79	4.68	23.23	7.35	39.41	20.87	22.00
Polasa prabha	80.06	68.10	62.53	3.10	5.24	1.51	3.57	25.87	8.93	70.94	14.97	22.80
Jagtial samba	74.80	64.89	54.55	3.01	4.38	1.65	4.47	22.40	9.28	51.87	13.47	25.28
Nellore mahsuri	77.00	68.31	59.91	2.80	5.55	1.51	5.33	23.30	9.04	63.83	11.17	23.51
Indra	78.35	66.77	64.05	2.83	4.15	1.26	6.27	28.27	5.83	39.23	15.57	24.55
Vijetha	76.72	62.33	51.99	2.67	5.77	1.31	7.20	28.90	8.34	62.77	17.50	22.77
Prabhat	80.02	68.16	58.07	2.51	5.20	1.50	3.20	26.10	8.52	54.00	12.27	27.48
Mean	**77.42**	**66.21**	**58.44**	**2.83**	**4.89**	**1.50**	**4.96**	**25.44**	**8.18**	**54.58**	**15.12**	**24.06**
CD (5%)	0.71	1.24	1.17	0.17	0.29	0.11	0.32	0.49	0.34	3.39	1.30	1.89
CV%	0.55	1.16	1.18	3.46	3.45	4.34	5.43	1.27	2.39	4.82	5.20	4.18

head rice recovery (%), length: breadth ratio, volume expansion ratio (VER), elongation ratio (ER) gelatinization temperature (GT), amylose content (%) protein content (%), iron content (ppm), zinc content (ppm) and yield per plant (g). The data were analyzed by Hayman's (1954) approach.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the parents, hybrids and parents verses hybrids for all the traits studied. The mean values of the quality characters were presented in table 1. The additive (D) and non-additive components (H_1) were significant for the traits *viz.,* hulling per cent, head rice recovery, elongation ratio, gelatinization temperature, amylose content and protein content. Both additive and non-additive gene action for elongation ratio was reported by Sarathe *et al.* (1986) and Singh and Singh (1982) reported for protein content. Whereas only dominant component was significant for length: breadth ratio, volume expansion ratio, iron content, zinc content and yield per plant (table 2). Sharma and Mani (1998) reported non-additive gene action for length: breadth ratio.

Higher magnitude of non-additive component (H_1) in comparison to additive component (D) indicated the greater importance of non-additive gene action while vice versa indicated the greater importance of additive gene action. The high value of heritability in narrow sense (h_2^2) also confirmed the predominance of additive nature of gene action.

The estimates of average degrees of dominance (A.D.D) greater than unity for all the traits indicating over dominance. Similar results were also reported by Verma *et al.* (1955), Sinha *et al.* (2006) and Sanjeev Kumar *et al.* (2008).

The non symmetrical distribution of positive and negative alleles was observed for all the traits (Table 2) as shown by $H_2/4H_1$. The K_D / Kr estimate in the present study revealed that higher proportion of dominant alleles for all the traits under study except for hulling per cent and protein content. The estimate of F-value confirmed the presence of dominant and recessive alleles in the parental population. The positive estimate of F indicated the over all excess of dominant alleles while negative sign for recessive alleles, as in case of length: breadth ratio. Significant values of F for hulling per cent and protein content indicated asymmetrical distribution of dominant and recessive genes in the parents.

Graphical analysis is a good estimator of the prepotency of parents and thus provides basis for choosing parental combination for selective improvements of the characters concerned. The

Table 2. Estimates of genetic components and other parameters for Quality characters in rice (*Oryza sativa* L.)

Component	Hulling (%)	Milling (%)	Head rice recovery (%)	L/B ratio	Volume expansion ratio	Elongation ratio
	1	2	3	4	5	6
D	4.594*±0.716	4.880±65.677	17.752*±5.198	0.036±0.038	0.499±0.367	0.032*±0.008
F	13.922*±3.436	27.437±315.116	10.115±24.938	-0.028±0.182	1.837±1.759	0.017±0.037
H_1	37.783*±6.897	926.822±632.464	205.795*±50.052	0.902*±0.365	11.404*±3.529	0.377*±0.074
H_2	25.747*±6.077	825.859±557.289	152.626*±44.103	0.747*±0.322	8.551*±3.110	0.368*±0.065
h^2	27.438*±4.082	18.089±374.301	58.193*±29.621	0.194±0.216	2.695±2.089	-0.002±0.044
E	0.070±0.253	0.206±23.220	0.182±1.838	0.004±0.013	0.012±0.130	0.001±0.003
Degree of dominance	1.434	6.891	1.702	2.517	2.390	1.729
$H_2/4H_1$	0.170	0.223	0.185	0.207	0.187	0.244
KD/Kr	-36.248	2.378	1.402	0.733	7.695	1.363
Va (Additive Gene Effects)	1.354	39.203	30.403	0.109	0.757	0.012
Vd (Dominance Deviations)	6.437	206.465	38.157	0.187	2.138	0.092
$h^{2\prime}/H_2$	1.066	0.022	0.381	0.260	0.315	-0.005

Component	Gelatinization temperature	Amylose content (%)	Protein content (%)	Iron (ppm)	Zinc (ppm)	Grain yield per plant (g)
	7	8	9	10	11	12
D	2.025*±0.571	6.512*±7.892	1.456*±0.389	147.016±307.033	10.649±5.589	3.094±3.521
F	4.940±2.740	27.919±37.865	5.284*±1.865	866.766±1473.133	22.649±26.815	16.696±16.894
H_1	25.243*±5.500	224.653*±75.999	19.147*±3.744	1017.961*±2956.696	303.657*±53.819	203.836*±33.908
H_2	21.665*±4.846	164.807*±66.966	11.630*±3.299	8352.808*±2605.264	281.243*±47.422	161.985*±29.878
h^2	40.672*±3.255	55.208±44.977	3.974±2.216	2797.659±1749.815	-0.024±31.851	273.566*±20.067
E	0.012±0.202	0.033±2.790	0.016±0.137	1.890±108.553	0.254±1.976	0.442±1.245
Degree of dominance	1.765	2.937	1.813	4.127	2.670	4.058
$H_2/4H_1$	0.215	0.183	0.152	0.208	0.232	0.199
KD/Kr	5.472	6.406	-2288.282	5.998	2.324	4.967
Va (Additive Gene Effects)	0.331	19.220	1.844	472.702	5.207	14.124
Vd (Dominance Deviations)	5.416	41.202	2.908	2088.202	70.311	40.496
$h^{2\prime}/H_2$	1.877	0.335	0.342	0.335	0.000	1.689

Table 3. Estimates of Vr+Wr values for quality traits in 7x7 diallel of rice

Variety	Hulling (%)	Milling (%)	Head Rice Recovery (%)	L/B Ratio	Volume Expansion ratio	Elongation Ratio	Gelatinization Temperature	Amylose content (%)	Protein content (%)	Iron (ppm)	Zinc (ppm)	Grain yield per plant (g)
	1	2	3	4	5	6	7	8	9	10	11	12
Samba mahsuri	7.670	32.202	28.365	0.086	1.325	0.056	1.325	10.300	0.648	486.291	19.460	14.628
Polasa prabha	1.064	9.235	37.308	0.073	0.758	0.070	2.315	0.278	-0.137	440.532	17.395	13.298
Jagtial samba	5.646	6.862	23.005	0.041	0.504	0.026	0.887	6.220	1.391	401.303	17.607	7.211
Nellore mahsuri	0.877	172.665	9.347	0.161	0.342	0.065	1.606	6.722	0.338	308.193	39.776	12.403
Indra	0.466	11.070	25.260	0.148	0.486	0.013	3.003	29.463	3.111	1115.591	13.818	8.509
Vijetha	0.010	9.039	32.306	0.107	0.247	0.033	3.663	17.079	1.110	117.680	11.753	15.455
Prabhat	0.900	143.047	10.849	0.032	0.793	0.045	0.291	13.719	0.392	777.708	30.579	6.911

values of (Vr +Wr) are presented in Table 3. The lowest value corroborates with the presence of more number of dominant genes while highest value to that more number of recessive genes. In the present study more number of recessive genes were present in Samba mahsuri followed by Jagtial samba and more number of dominant genes in Vijetha and Indra for hulling per cent. More number of dominant genes for milling per cent was possessed by Jagtial samba followed by Polasa prabha and Vijetha.

More number of dominant genes for head rice recovery was possessed by Nellore mahsuri and recessive genes in Polasa prabha. Prabhat possess more dominant genes for length: breadth ratio, whereas Nellore mahsuri possess more number of recessive genes which can be exploited for getting slender grains. More number of recessive genes were possessed by Indra and Vijetha for gelatinization temperature, amylose content and protein content. More number of recessive genes were possessed by India for iron content and Nellore mahsuri for zinc content, where as more number of dominant genes were possessed by Vijetha for both iron and zinc contents.

In the present study out of twelve characters studied, six were observed for both additive and non-additive gene actions and these traits can be improved through hybridization programme, while five showed only non-additive gene action. The cultivar Samba mahsuri might be the best parent in the breeding programme for further improvement of cooking characters. Vijetha and Indra are the best donors for improving nutritional characters.

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