



Research Article

GENETIC VARIABILITY AND CHARACTER ASSOCIATION STUDIES IN RICE UNDER RAINFED SHALLOW LOWLAND AT NEW ALLUVIAL ZONE OF WEST BENGAL

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Abstract- Forty-nine rice genotypes including three check varieties were evaluated in RBD with two replications in a field experiment during Kharif season at Regional Research Sub Station: Chakdaha, New Alluvial Zone of Bidhan Chandra Krishi Viswavidyalaya. The analysis revealed significant differences among the genotypes against all the characters studied. In general, phenotypic variance was higher than the corresponding genotypic variance for all the characters studied. Characters like number of panicles per plant, panicle weight(g), number of grains per panicle and number of secondary branches per panicle recorded high phenotypic and genotypic variances simultaneous with PCV and GCV. High estimate of genetic advance was obtained for number of florets per panicle, plant height and number of grains per panicle. High heritability along with high genetic advance as percent of mean was obtained for number of primary branches per panicle, number of panicle per plant, plant height, grain length and kernel length breadth ratio. Grain yield per plant was significantly correlated with number of panicle per plant, panicle weight, number of florets per panicle, number of grains per panicle, harvest index and fertility percentage in positive direction. Path coefficient analysis revealed the high direct effect of number of panicles per plant, panicle weight, number of florets per panicle and floret fertility on grain yield.

Keywords- Rice, Rainfed, Genetic Variability, Genetic Advance, Correlation and Path Co-Efficient.

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Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop in the world, directly feeding more people than any other crop. India is the second largest producer of rice with a production of 156.1 million tonnes (106.65 million tonnes in milled basis) in 2014-15 [1] and cropping coverage of 45 million hectares. In India, 30-40% of rice has been cultivated under rainfed condition, contributing nearly 20% of the total rice production in India. The shallow rice areas where depth of standing water is below 20 cm [2], is in the eastern states viz., Assam, Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. Variability in rainfall and its distribution normally cause either flood or drought stresses in rainfed lowland rice production system. The average productivity of rice in low land areas ranges from 1.0 to 1.2 tonnes per hectare as against the national average productivity of 1.9 tonnes per hectare indicating the scope for further improvements in productivity. Therefore, the present study was to assess the extent of genetic variability, correlation and path coefficient analysis among forty-nine rice genotypes that could be exploited in further rice improvement programme.

Materials and Methods

The present investigation was conducted during kharif season 2014 at Regional Research Sub Station: Chakdaha, New alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, Chakdah, Nadia, West Bengal. The experimental field is situated at 23° -30' N, longitude 89° E and altitude 9.75 m (above mean sea level) in New Alluvial Zone of West Bengal, India. The material consisted of 49 genotypes [Table-1] including MTU-70291, Swarna sub-1 and Dhanarasi as local, regional and national check varieties respectively. Experiment was laid out in Randomized

Block Design with two replications. Recommended cultural practices were followed to obtain a good harvest. Five plants were selected randomly from each entry in each replication to record the yield and its attributing characters viz., Days to 50% flowering, Days to maturity, Plant height (cm), Number of panicles per plant, Panicle weight (g), Panicle length (cm), Number of primary branches per panicle, Number of secondary branches per panicle, Number of florets per panicle, Number of grains per panicle, Floret fertility (%), 1000 grain weight (g), Grain length (mm), Grain breadth (mm), Grain L/B ratio, Kernel length (mm), Kernel breadth (mm), Kernel L/B ratio, Harvest index (%) and Seed Yield per plant (g). Statistical analysis was done by using the online software OPSTAT developed by Haryana Agricultural University, Hisar. The analysis of variance for different characters was carried out to assess the genetic variability among genotypes as given by Cochran and Cox [3]. The level of significance was tested at 5% and 1% using F table values given by Fisher and Yates [4]. Correlation coefficients were estimated as suggested by Burton [5] and path analysis was carried out following Dewey and Lu [6].

Results and Discussion

Analysis of variance [Table-2] revealed significance differences among all the genotypes against all characters studied. It was observed that phenotypic variance was higher than the corresponding genotypic variance for all characters chosen under investigation [Table-3]. Highest estimates of genotypic and phenotypic variances were recorded for number of grains per panicle followed by number of florets per panicle, number of panicles per plant, number of secondary branches per panicle, panicle weight and grain yield per plant while it was lowest for grain breadth followed by kernel breadth and kernel L/B ratio respectively. The

Table-1 List of different Rice genotypes and their parentage

S.No.	Designation of Genotype	Cross combination/ Parentage	S.No.	Designation of Genotype	Cross combination/ Parentage
1	OR 2329-3	OR- 1530 / IR 68181-8-49	26	CR 3696-1-2-2-1-1	CR 662-2-2-1-1 / Sarala/ CR780- 1937-1-3/DRR1702
2	OR 1898-32-69-CN 12-12	Selection	27	CR 3607-8-1-2-1-1	Gayatri/ Sudhir // Varshadhan
3	CR 3815-1-1-1-1	CR Dhan500 / CR662-2-2-1-1-1	28	CR 3697-3-2-2-2-1	CR 662-2-2-1-1 / Sarala/CR780- 1937-1-3/DRR1702
4	CR 3607-11-2-1-1-3	Savitri/ Sudhir // Varshadhan	29	OR 2552-2	Pratikshya / IR62140
5	OR 2380-2	Mahanadi/ RAYADA-B3	30	CHR 25/CHK 02- 2-11-7-20-1-2-47	Sabita / Samba Mashuri
6	CR 3856-44-22-2-1-11	IR 73963-86-1-5-2-2/CR 2324-2-1	31	CR 2683-7-1-2-2-3-2	CRLC 899 / AC.38700
7	BRR 2031	Rajashree Sel.	32	CR 2683-7-1-2-1-1	CRLC 899 / AC.38700
8	MGD-1404	BA 231-1 / BPT-5204/ Antarsali	33	CR 3696-5-5-2-2-1	Gayatri / Warda1
9	BRR 2002	R.D.201 / CR 157- 392	34	OR 2405-KK-27	OR 1206-26-2 / IR 62140
10	CR 3808-55	Selection from male sterility facilitated recurrent selection population	35	CR 2683-45-1-2-1-1	CRLC 899 / AC.38700
11	NDR 40175-8	Madhukar / sona	36	NDR-40165-4	Rankay / Sona
12	CN 1960-10-10	Koushalya / NDR 97	37	CR 3505-2-1-2-2-1	Gayatri / Jalmagna
13	OR 2380-3	Mahanadi / Rayada B3	38	OR 2330-1-1	OR- 1530-1 / NDR 8003
14	BRR 2028	Radha Sel.	39	CR 3607-12-1-1-1-2	Gayatri/ Sudhir // Varshadhan
15	MGD-1403	IR-43581 / IR26940-20-3-3-3/ KDML-105	40	CR 3614-1-1-1-1-1	CR780- 1937-1 / Ratna
16	TTB 281-9-2-1	Borsali / Kushal	41	CR 3818-1-1-1-1-2	Hanseswari / AC.38671
17	BRR 2030	Rajashree selection	42	CR 3840-1-5-1-2-1	Jalmagna / Mashuri
18	CN 1740-19-550-11-15-MLD11-2	IR42/Progol // CN540//IR656000-96-1-2	43	CR 3844-1-1-4-1	CR 662-2-2-1 / Sarala
19	CR 2794-6-2-1	Ranjeet / Gayatri// CR-997	44	CR 2681-2-3-1-1-1	Gayatri/Warda2
20	CRL 9-15-6-6-40-1	Goutam / HUR AFG 4-2	45	CO 43 Sub-1	Co 43 / FR13A
21	CN 1956-8-3	Swarna / Giri	46	CO 43	Recurrent parent
22	TTB 281-9-2-2-7	Borsali / Kushal	47	Dhanrasi (NC)	B 32-Sel-4 / O. rufipogon / B 127
23	RP 5877-ME 80518	Yuefengzhan / E- Zhong5	48	MTU 70291 (LC)	
24	RP 5880-SACG 4	C418/(Zhong413)*2 // M202/(Zhong413)*2	49	Swarna sub-1 (RC)	MTU 7029 / IR 49830
25	RP 5881- WEED TOL. RICE1	Woushanyouzhon / P1312777			

Table-2 Analysis of variance for various characters in 49 genotypes of rice

		Source of variation with degrees of freedom (d.f.)		
		Replication (1)	Genotypes (48)	Error (48)
1	Days to 50 % maturity	0.367	91.083**	2.367
2	Days to maturity	4.500	84.011**	7.688
3	Plant height (cm)	2.296	565.547**	8.483
4	No of panicles per plant	3.380	15.498**	1.688
5	Panicle weight (g)	0.136	0.885**	0.185
6	Panicle length (cm)	0.013	18.545**	1.15
7	No. of primary branches per panicle	0.007	7.977**	0.791
8	No. of secondary branches per panicle	0.845	74.434**	1.699
9	Number of Florets per panicle	1245.718	3943.284**	1906.244
10	Number of grains/panicle	129.605	2034.469**	788.028
11	Floret fertility (%)	82.451	244.861**	145.047
12	1000 grain weight (g)	0.017	21.465**	7.768
13	Grain length (mm)	0.002	1.596**	0.016
14	Grain breadth (mm)	0.059	0.095*	0.014
15	Grain L/B ratio	0.128	0.561**	0.033
16	Kernel length (mm)	0.019	0.843**	0.038
17	Kernel breadth (mm)	0.004	0.128*	0.012
18	Kernel L/B ratio	0.004	0.66**	0.02
19	Harvest index (%)	0.674	28.695**	0.289
20	Yield/ plant (g)	6.919	39.107**	3.38

d.f. = Degrees of freedom Values given in Parenthesis, ** Significant at 1 % level of significance, * Significant at 5% level of significance

Table-3 Variability and genetic parameters of various characters

S.No	Plant character	Range	Mean	Variance			GCV	PCV	h ² (bs) (%)	GA	GA as % of Mean
				GV	PV	EV					
1	Days to 50 % flowering	101.5 - 131.50	119.14	29.57	31.94	2.37	4.56	4.74	92.59	10.78	9.05
2	Days to maturity	133.5 - 162.00	147.83	25.44	33.13	7.69	3.41	3.89	76.79	9.11	6.16
3	Plant height (cm)	95.5 - 165.50	124.89	185.69	194.17	8.48	10.91	11.16	95.63	27.45	21.98
4	No of panicles per plant	7.00 - 20.00	11.83	4.60	6.29	1.69	18.14	21.20	73.17	3.78	31.96
5	Panicle weight (g)	1.48 - 4.39	2.79	0.23	0.42	0.19	17.31	23.18	55.78	0.74	26.64
6	Panicle length (cm)	20.12 - 31.00	25.3	5.80	6.95	1.15	9.52	10.42	83.45	4.53	17.91
7	No. of primary branches per panicle	8.10 - 16.80	11.9	2.40	3.19	0.79	13.01	15.00	75.18	2.76	23.23
8	No. of secondary branches per panicle	15.40 - 46.3	31.34	24.25	25.94	1.70	15.71	16.25	93.45	9.81	31.29
9	Number of florets per panicle	107.9 - 183.22	183.21	679.01	2585.26	1906.24	14.22	27.75	26.26	27.51	15.02
10	Number of grains per panicle	79.25 - 219.0	129.58	415.48	1203.51	788.03	15.73	26.77	34.52	24.67	19.04
11	Floret fertility (%)	45.92- 87.44	71.51	33.27	178.32	145.05	8.07	18.67	18.66	5.13	7.18
12	1000 grain weight (g)	15.98 - 30.01	22.35	4.57	12.33	7.77	9.56	15.71	37.02	2.68	11.98
13	Grain length (mm)	7.54 - 11.24	9.06	0.53	0.54	0.02	8.01	8.13	97.05	1.47	16.26
14	Grain breadth (mm)	1.89 - 2.94	2.58	0.03	0.04	0.01	6.37	7.85	65.85	0.27	10.65
15	Grain l/b ratio (mm)	2.59 - 4.72	3.57	0.18	0.21	0.03	11.75	12.81	84.21	0.79	22.21
16	Kernel length (mm)	6.34 - 8.80	7.31	0.27	0.31	0.04	7.09	7.57	87.60	1.00	13.66
17	Kernel breadth (mm)	1.73 - 2.82	2.33	0.04	0.05	0.01	8.44	9.66	76.32	0.35	15.19
18	Kernel l/b ratio	2.40 - 5.17	3.22	0.21	0.23	0.02	14.34	15.00	91.43	0.91	28.25
19	Harvest index (%)	38.00 - 50.97	44.67	9.47	9.76	0.29	6.89	6.99	97.04	6.24	13.98
20	Seed Yield/plant (g)	15.32 - 30.41	23.71	11.91	15.29	3.38	14.55	16.49	77.89	6.27	26.46

magnitude of PCV was higher than GCV for all the characters studied, indicated environmental influences on the expression of these characters. This observation was like earlier findings of Senapati *et al.* [7]; Akinwale *et al.* [8]; Nitiprasad *et al.* [9] in rice. High GCV and PCV values noticed for number of panicles per plant, panicle weight, number of grains per panicle, number of secondary branches per panicle, number of florets per panicle, kernel L/B ratio, number of primary branches, grain L/B ratio and plant height. Ashok *et al.*, earlier corroborated these findings [10] for number of panicles per plant, number of florets per panicle, number of grains per panicle, and panicle weight, by Sravan *et al.* [11] for number of grains per panicle and by Romel *et al.* [12] for number of secondary branches per panicle. High broad sense heritability was recorded for all characters studied except floret fertility, number of florets per panicle, number of gains per panicle, 1000 grain weight and panicle weight. Genetic advance as percent of mean was highest for number of panicles per plant followed by number of secondary branches per panicle, panicle weight, kernel L/B ratio and seed yield per plant. Patel *et al.*, earlier reported similar finding [13] for seed yield per plant. High heritability coupled with high genetic advance as percent of mean was obtained for number of primary branches per panicle, number of panicles per plant, plant height, grain length and kernel L/B ratio that highlighted the role of additive gene action in controlling of these characters. Therefore, direct selection would be effective for improvement of these characters. This agreed with the earlier findings of Sumanth *et al.* [14] for number of panicles per plant and Ragvendra *et al.* [15] for plant height. High heritability coupled with moderate genetic advance as percentage of mean was observed for panicle length, days to 50% flowering, harvest index, kernel breadth, number of secondary branches per panicle, grain length breadth ration, grain breath and days to maturity which indicating presence of both additive and non-additive gene action for these characters and hence direct selection would not be effective for improving these characters. High heritability coupled with low genetic advance as percent of mean was recorded for seed yield per plant which suggesting the presence of non- additive gene action and direct selection for these characters may not be rewarding.

Correlation co-efficient analysis

The genotypic and phenotypic correlation coefficients between grain yield per plant and its attributing traits are presented in [Table-4]. Grain yield per plant exhibited positive and significant correlation at genotypic and phenotypic level with number of panicle per plant ($r_g=0.598$ and $r_p=0.565$), panicle weight ($r_g=0.520$ and 0.509), number of florets per panicle ($r_g=0.355$ and $r_p=0.207$), number of grains per panicle ($r_g=0.433$ and $r_p=0.321$) and harvest index ($r_g=0.652$ and $r_p=0.606$), while it was only at genotypic level with fertility percentage($r_g=0.299$). It had also significant negative correlation with number of primary branches per panicle ($r_g=0.219$) at genotypic level. These findings agreed with that of Sawarkar and Senapati [16] and Chandrashekhar [17] for number of panicles per plant, number of grains per panicle and floret fertility percentage and Madhavilatha *et al.* [18] for number of number of grains per panicle and harvest index.

Path Coefficient Analysis

The direct and indirect contribution of yield attributing characters on yield per plant presented in [Table-5]. The correlation coefficient of each independent quantitative character was partitioned into direct and indirect effect towards grain yield. In the present investigation residual effect was very low (0.044). Therefore, it revealed that the number of characters chosen for the study were very much appropriate for determination of yield in rice. Nearly half of the characters viz., days to maturity, number of panicles per plant, panicle weight, number of primary branches, number of secondary branches, number of florets per panicle, florets fertility, grain length, kernel breadth and kernel L/B ratio imparted positive direct effects towards grain yield. Characters like number of panicles per plant, panicle weight, number of florets per panicle and floret fertility had high positive direct effect and significant positive correlation, suggested the need for emphasis on these characters during selections for yield improvement. These results were supported earlier by Allam *et al.* [19] for number of panicles per plant and number of florets per panicle.

Though kernel L/B ratio imparted the highest positive direct effect on grain yield per plant, but negative correlation coefficient with grain yield indicated that the negative indirect effects were the cause of manifestation of the correlation.

Table-4 Genotypic and Phenotypic correlations among yield and its attributes of rain fed low land Rice

		Days to Maturity	Plant height at maturity (cm)	Number of panicles/plant	Panicle weight(g)	Panicle Length (cm)	No. of primary branches/plant	No. of secondary branches/plant	Number of Florets/ plant	Number of grains/ plant	Floret fertility (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Harvest index(%)	Seed yield/ plant (g)
Days to 50% flowering	G	0.958**	-0.029	-0.169	-0.003	0.07	0.101	0.296**	0.428**	0.127	-0.440**	-0.255*	0.323**	-0.068	0.267**	0.397**	-0.008	0.211*	-0.365**	-0.092
	P	0.872**	-0.031	-0.179	-0.033	0.055	0.115	0.287**	0.245*	0.032	-0.252*	-0.149	0.316**	-0.041	0.235*	0.372**	-0.009	0.196	-0.359**	-0.099
Days to maturity	G		0.026	-0.229*	0.069	0.145	0.024	0.277**	0.466**	0.252*	-0.409**	-0.257*	0.292**	-0.181	0.303**	0.308**	-0.105	0.220*	-0.376**	-0.09
	P		0.013	-0.198	0.044	0.119	0.012	0.252*	0.275**	0.114	-0.197	-0.151	0.269**	-0.122	0.252*	0.300**	-0.058	0.185	-0.338**	-0.066
Plant height (cm)	G			-0.209*	0.328**	-0.054	-0.051	-0.07	0.189	-0.015	-0.168	0.402**	0.281**	-0.241*	0.330**	0.274**	-0.105	0.207*	-0.279**	-0.072
	P			-0.178	0.260**	-0.037	-0.061	-0.068	0.073	-0.021	-0.09	0.252*	0.269**	-0.199*	0.302**	0.256*	-0.081	0.189	-0.277**	-0.057
No. of Panicles/ Plant	G				-0.228*	-0.048	-0.087	-0.338**	-0.222*	0.157	0.531**	-0.129	-0.173	-0.014	-0.134	-0.277**	-0.007	-0.128	0.552**	0.598**
	P				-0.171	-0.057	-0.119	-0.315**	-0.127	0.088	0.258*	-0.116	-0.166	-0.043	-0.103	-0.240*	0.005	-0.124	0.517**	0.565**
Panicle weight (g)	G					0.235*	0.011	0.047	0.521**	0.287**	-0.056	0.659**	0.375**	0.113	0.181	0.494**	0.201*	0.095	0.159	0.520**
	P					0.219*	0.025	0.054	0.382**	0.394**	0.105	0.261**	0.305**	0.033	0.177	0.381**	0.114	0.083	0.139	0.509**
Panicle length (cm)	G						0.226*	0.528**	0.336**	-0.007	-0.548**	-0.011	0.415**	0.051	0.230*	0.376**	-0.254*	0.402**	-0.036	0.208*
	P						0.222*	0.518**	0.19	0.062	-0.219*	-0.039	0.389**	0.075	0.184	0.332**	-0.207*	0.357**	-0.036	0.171
No. of Pri.Branch/panicle	G							0.482**	-0.01	-0.169	-0.119	0.381**	0.045	0.031	0.013	0.174	0.05	0.057	0.022	-0.219*
	P							0.483**	-0.004	-0.106	-0.117	0.182	0.056	0.081	-0.018	0.16	0.037	0.066	0.016	-0.179
No. of Sec.Branch/panicle	G								0.407**	-0.003	-0.591**	-0.022	0.193	-0.004	0.128	0.255*	-0.03	0.19	-0.07	-0.117
	P								0.269**	0.039	-0.277**	-0.024	0.191	0.015	0.112	0.235*	-0.043	0.192	-0.068	-0.112
No. Florets/ Panicle	G									0.786**	-0.544**	-0.073	0.302**	-0.103	0.286**	0.389**	0.018	0.147	0.056	0.355**
	P									0.627**	-0.237*	0.067	0.193	-0.065	0.167	0.216*	-0.095	0.141	0.069	0.207*
No. of grains/ Panicle	G										0.398**	0.314**	0.023	-0.133	0.074	0.093	0.07	-0.064	0.270**	0.433**
	P										0.434**	0.048	0.011	-0.097	0.054	0.018	-0.058	-0.009	0.200*	0.321**
Floret fertility (%)	G											0.168	-0.361**	-0.172	-0.168	-0.267**	0.17	-0.280**	0.384**	0.299**
	P											0.236*	-0.189	-0.103	-0.074	-0.16	0.038	-0.142	0.195	0.183
1000 grain weight (g)	G												0.392**	0.166	0.171	0.508**	0.008	0.266**	-0.018	0.131
	P												0.286**	0.032	0.161	0.349**	0.015	0.18	-0.001	0.04
Grain length (mm)	G													-0.267**	0.825**	0.933**	-0.489**	0.831**	-0.327**	0.118
	P													-0.205*	0.772**	0.895**	-0.435**	0.800**	-0.318**	0.101
Grain breadth (mm)	G														-0.758**	-0.236*	0.710**	-0.534**	0.199*	0.024
	P														-0.771**	-0.185	0.561**	-0.437**	0.166	-0.047
Grain L/B ratio	G															0.769**	-0.725**	0.864**	-0.349**	0.041
	P															0.696**	-0.618**	0.785**	-0.321**	0.073
Kernel length (mm)	G																-0.369**	0.788**	-0.340**	0.142
	P																-0.276**	0.743**	-0.321**	0.127
Kernel breadth (mm)	G																	-0.847**	0.333**	0.162
	P																	-0.828**	0.306**	0.128
Kernel L/B ratio	G																		-0.394**	-0.039
	P																		-0.382**	-0.037
Harvest Index (%)	G																			0.652**
	P																			0.606**

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

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Table-5 Path Coefficient (Genotypic) showing direct (Bold) and indirect effects of component traits in 49 rice genotypes

	Days to 50% flowering	Days to maturity	Plant height at maturity (cm)	Number of panicles/plant	Panicle weight(g)	Panicle length(cm)	No. of Primary branches/plant	No. of Secondary branches/plant	Number of florets/ plant	Number of grains/ plant	Floret fertility (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Harvest index	Seed yield / Plant
Days to 50% flowering	-0.25055	0.03525	0.00125	-0.10945	-0.00264	-0.01085	0.00341	0.0364	0.16224	-0.00922	-0.15236	0.13651	0.21688	0.02348	-0.24479	-0.16346	-0.00496	0.24041	0.00014	-0.092
Days to maturity	-0.24002	0.03679	-0.00109	-0.14845	0.05676	-0.02254	0.00082	0.03413	0.17657	-0.01823	-0.14167	0.13763	0.19585	0.0628	-0.27794	-0.12675	-0.06604	0.25166	0.00015	-0.09
Plant height	0.00736	0.00094	-0.04259	-0.13539	0.27142	0.00841	-0.00001	-0.00864	0.07156	0.0011	-0.0584	-0.21516	0.18812	0.08349	-0.30187	-0.11275	-0.06588	0.23623	0.00011	-0.072
No. of panicles/plant	0.04225	-0.00842	0.00888	0.64903	-0.18875	0.00752	-0.00293	-0.04165	-0.08391	-0.01139	0.18397	0.0691	-0.11567	0.00488	0.12259	0.11424	-0.00462	-0.14665	-0.00022	0.598* *
Panicle weight	0.0008	0.00253	-0.01399	-0.14824	0.82638	-0.03658	0.00036	0.00583	0.19737	-0.0208	-0.01937	-0.35205	0.25116	-0.03931	-0.16596	-0.20334	0.12659	0.10828	-0.00006	0.520* *
Panicle length	-0.0175	0.00534	0.00231	-0.03143	0.19457	-0.15534	0.00762	0.06508	0.12724	0.00054	-0.18998	0.00564	0.2784	-0.01753	-0.21042	-0.1549	-0.15988	0.45842	0.00001	0.208*
No. of Pri.Branch/plant	-0.02538	0.0009	0.00001	-0.05656	0.00891	-0.03516	0.03367	0.05931	-0.00387	0.01226	-0.04121	-0.20361	0.03019	-0.01089	-0.0116	-0.07149	0.03132	0.06457	-0.00001	- 0.219*
No. of Sec.Branch/plant	-0.07407	0.0102	0.00299	-0.21952	0.03914	-0.0821	0.01622	0.12314	0.15428	0.00019	-0.20485	0.01162	0.12952	0.00013	-0.11696	-0.10487	-0.01895	0.21734	0.00003	-0.117
No. Florets/ Panicle	-0.10733	0.01715	-0.00805	-0.1438	0.43066	-0.05219	-0.00034	0.05016	0.37873	-0.05691	-0.18843	0.03915	0.2022	0.03577	-0.26158	-0.16007	0.0115	0.1683	-0.00002	0.355* *
No. of grain/ Panicle	-0.0319	0.00926	0.00065	0.10202	0.23725	0.00116	-0.0057	-0.00033	0.29751	-0.07245	0.13811	-0.16777	0.01516	0.04601	-0.06813	-0.03833	0.04377	-0.07352	-0.00011	0.433* *
Floret fertility (%)	0.11012	-0.01504	0.00718	0.34444	-0.04616	0.08513	-0.004	-0.07277	-0.20587	-0.02887	0.34665	-0.08972	-0.24201	0.05967	0.15372	0.10997	0.1069	-0.32001	-0.00015	0.299* *
1000 grain weight	0.06398	-0.00947	-0.01714	-0.08389	0.54422	0.00164	0.01283	-0.00268	-0.02774	-0.02274	0.05818	-0.53457	0.26302	-0.05766	-0.1563	-0.20939	0.00483	0.30383	0.00001	0.131
Grain length	-0.08105	0.01075	-0.01195	-0.11197	0.30958	-0.06451	0.00152	0.02379	0.11422	-0.00164	-0.12513	-0.20971	0.67045	0.0925	-0.75539	-0.3843	-0.30791	0.94864	0.00013	0.118
Grain breadth	0.01696	-0.00666	0.01025	-0.00913	0.09363	-0.00785	0.00106	-0.00005	-0.03905	0.00961	-0.05962	-0.08885	-0.17876	-0.34693	0.69417	0.09715	0.44682	-0.60913	-0.00008	0.024
Grain L/B ratio	-0.06696	0.01117	-0.01404	-0.08687	0.14973	-0.03569	0.00043	0.01572	0.10816	-0.00539	-0.05818	-0.09123	0.55294	0.26293	-0.91592	-0.31655	-0.45621	0.98639	0.00014	0.041
Kernel length	-0.09945	0.01132	-0.01166	-0.18004	0.40804	-0.05843	0.00585	0.03136	0.14721	-0.00674	-0.09257	-0.2718	0.62563	0.08184	-0.70401	-0.41182	-0.23219	0.89968	0.00013	0.142
Kernel breadth	0.00197	-0.00386	0.00446	-0.00477	0.16628	0.03948	0.00168	-0.00371	0.00692	-0.00504	0.0589	-0.00411	-0.32811	-0.24638	0.66414	0.15199	0.62916	-0.96686	-0.00013	0.162
Kernel L/B ratio	-0.05276	0.00811	-0.00881	-0.08337	0.07838	-0.06238	0.0019	0.02344	0.05583	0.00467	-0.09717	-0.14227	0.55709	0.1851	-0.79135	-0.32453	-0.53282	1.14167	0.00015	-0.039
Harvest index	0.09152	-0.01385	0.01187	0.35827	0.13151	0.00562	0.00075	-0.00863	0.02136	-0.01956	0.13319	0.00942	-0.21932	-0.0692	0.31944	0.13982	0.20949	-0.44945	-0.00039	0.652* *

Residual effects R²=0.044, ** Significant at 1 % level of significance, * Significant at 5% level of significance

Therefore, a restricted selection model may be followed to nullify the undesirable indirect effects to make the use of high positive direct effect of kernel L/B ratio in rice improvement programme. It was observed that grain length and kernel breadth incurred a high positive direct effect on grain yield simultaneous with nearly significant value of correlation coefficient with grain yield and the positive direct effect along with nearly significant correlation coefficient of kernel breadth towards grain yield. Therefore, during selection these characters may also be considered for the yield improvement in Rice.

Conclusion

Present investigation highlighted the differential performance of the genotypes against the characters studied and this may provide a good source of materials for further breeding program. Based on results as depicted above, it is concluded that the great deal of variability was present for the important characters studied even in highly selected lines under the present investigation. High heritability with high genetic advance for number of panicles per plant, panicle weight, their strong and positive correlation, and the positive direct effect on grain yield per plant indicated their due importance as the indicator characters and their manipulation through selection. These characters can be utilized as selection criteria for the development of high yielding lowland varieties suitable for rain fed ecosystem.

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Abbreviations

%-percentage, cm-Centimetre, g-gram, E-East, *et al.*-et alia, GCV- genotypic co-efficient of variation, L/B ratio-Length/Breadth ratio, m-metre, mm-millimetre, N-North, PCV-Phenotypic co-efficient of variation, RBD-Randomised Block design, rg=genotypic correlation, rp-Phenotypic correlation.

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