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Polygenic variations and cause effect relationship in some photo-insensitive recombinant inbred lines (RIL's) of Basmati derivative

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The present investigation consisted 18 photo-insensitive recombinant inbred lines (RILs) of Basmati derivative developed through disruptive seasonal selection and two check varieties raised during Kharif 2010 to study the polygenic variations in yield and yield attributing characters and their cause and effect relationship. Seven RILs viz., Bidhan Moti 6, 10, 11, 15, 23 and 30 surpassed the check varieties that is, Satabdi (IET 4786) and Khitish (IET 4094) in respect of grain yield and some other yield related traits. The maximum range of variation in mean was observed for floret number/panicle followed by number of grains/panicle, plant height and fertility percentage. The highest estimate of phenotypic and genotypic variances was observed for floret number /panicle followed by number of grains/ panicle and plant height. High estimates of genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were obtained for grain yield/plant, number of grains/panicle, panicle weight and floret number/panicle. High heritability was observed for floret number/panicle, fertility percentage, kernel length, panicle weight, grain length, number of panicle/plant, kernel length (L)/breadth (B) (L/B) ratio, grain breadth and days to maturity. Grain yield showed positive significant correlation with number of panicles/ plant, number of grains/ panicle and fertility percentage. Path coefficient analysis revealed that seven characters viz. plant height, days to 50% flowering, number of panicles/plant, panicle length, number of grains/ panicle, grain length and kernel breadth had positive direct effect on grain yield while nine characters namely days to maturity, panicle weight, floret number/panicle, fertility percentage, grain breadth, grain L/B ratio, kernel length, kernel L/B ratio and 1000 grain weight incurred negative direct effect on grain yield.

Key words: Basmati derivative, recombinant inbred line (RIL), kernel length (L)/breadth (B) (L/B) ratio, polygenic variability, direct effect.

INTRODUCTION

Generally, the export quality traditional basmati varieties are tall in nature but poor yielders. In order to improve the yield potential without sacrificing the special quality features, knowledge on the correlation between yield and its component characters can help improve the efficiency of selection. Correlation studies permit only a measure of relationship between two traits. Hence, path coefficient analysis becomes necessary as it indicate separation of direct and indirect effects via other related characters by partitioning through correlation coefficients that helps in designing appropriate breeding procedure for evolving high yielding genotypes. In the present investigation, an

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attempt has been made to assess the variability and cause effect characters with grain yield / plant in a newly developed recombinant inbred line (RIL), of Basmati derivative.

MATERIALS AND METHODS

Initially three high yielding varieties of rice viz., IR 30, Swarna and MTU 7029 were taken as female parent and crossed with Basmati 370 during *Kharif* 2001 at Regional Research Station (Sub-Centre Chakdaha) of BCKV, Nadia, West Bengal. F1' and F2's were raised and evaluated during *Kharif* 2002 and *Kharif* 2003, respectively. Due to lack of desirable plant types in the F2 progenies, Swarna × Basmati 370 and MTU 7029 × Basmati 370 were discarded. Selection were made among the F2 progenies of IR 30 × Basmati 370 cross derivatives based mainly on grain yield, earliness and grain shape, that is, grain length (L), grain breadth (B), grain L/B ratio. From the F3 generation and onwards, disruptive seasonal selection was practiced up to F10th generation among the early selected lines of the said cross derivatives. In disruptive seasonal selection, crop was raised in two contrasting seasons that is, during *Kharif* season (June to December) as normal crop that is, winter rice and during boro season (November-December to April) as summer rice. Finally, 18 uniform RILs were developed. They were designated as Bidhanmoti 1, Bidhanmoti 2, Bidhanmoti 3, Bidhanmoti 5, Bidhanmoti 6, Bidhanmoti 8, Bidhanmoti 10, Bidhanmoti 11, Bidhanmoti 14, Bidhanmoti 15, Bidhanmoti 16, Bidhanmoti 17, Bidhanmoti 21, Bidhanmoti 22, Bidhanmoti 23, Bidhanmoti 24, Bidhanmoti 26 and Bidhanmoti 30, respectively. The experiment was carried out with these RILs at Instructional Farm (latitude 22° 93' N, longitude 88.59°E and altitude 9.75 m above mean sea level), Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia during Kharif 2010. The soil, gangetic alluvial sandy loam in texture, with good water holding capacity (65%) having medium in fertility and neutral.

Thirty one days age old seedlings were transplanted in the field having a plot size of 5.0 × 2.0 m against each entry. The experiment was laid out in randomized block design with three replications having a spacing of 20 cm from row to row and 15 cm distance from plant to plant. Normal agronomic practices were followed to obtain a good harvest. Observations were recorded on 17 yield attributing characters such as plant height (cm), days to 50% flowering, days to maturity, number of panicles per plant, panicle weight (g), panicle length (cm), 1000 grain weight (g), number of florets per plant, number of grains per plant, fertility percentage (%), grain length (mm), grain breadth (mm), grain length/breadth ratio, kernel length (mm), kernel breadth (mm), kernel length/breadth ratio, grain yield per plant (g/pl) (Table 1) from the five randomly selected plants from each entry. Mean data were statistically analyzed for variance components as per Burton (1952). Heritability (Broadsense) and genetic advance were estimated following Hanson et al. (1956) and Johnson et al. (1955), respectively. Path analysis was done according to Dewey and Lu (1959).

RESULTS AND DISCUSSION

Estimated mean performance for different traits of RILs and check varieties are presented in Table 1. All the lines exhibited considerable variability for all the characters studied. A comparatively dwarf stature was observed for Bidhan Moti 2, 6, 16, 24, Satabdi (IET 4786) and rest of the lines belonged to the semi dwarf group. Bidhan Moti 2, 3, 6, 10, 26, Satabdi and Khitish (IET 4094) were flowering earlier in comparison to other genotypes like Bidhan Moti 11, 22, 17, 30. Bidhan Moti 8, 10, 14, 17, 26 accounted for more number of days to mature than the rest of the genotypes. Bidhan Moti 5, 6, 11, 17, 30 recorded more number of panicles/plant than two check varieties and rest of the lines. Bidhan Moti 11 was the best performer against panicle weight (2.82 g) followed by Bidhan Moti 5, 6, 15 and Satabdi (IET 4786), respectively. Panicle length ranged from 22.63 to 27.50 cm of which four lines Bidhan Moti 3, 10, 11, 22 belonged to high ranking group. Floret number/panicle ranged from 111.83 to 203.16 of which Bidhan Moti 22 was the best performer followed by Bidhan Moti 5 and Bidhan Moti 11 in this regard. In case of number of grains/panicle, Bidhan Moti 6, 23 and 24 showed superior performance while Bidhan Moti 1, 3 and 21 showed poor performance against the concerned trait. A wide range of variation was observed for fertility percentage (47.45 to 87.41%). Khitish (IET- 4094) was the top scorer followed by Bidhan Moti 6, 14, 15 and 26. All of the RILs possessed extra long grain length. The minimum value (8.23 mm) was observed in Bidhan Moti 30 while the maximum value was registered by Bidhan Moti 26 (11.56 mm) followed by Bidhan Moti 21 (11.40 mm) and Bidhan Moti 1(11.33 mm), respectively. Grain breadth, one of the important features of rice which is one of the important criteria for the market price, showed lesser degree of variation in comparison to other characters. Bidhan Moti 14 recorded the minimum value (1.53 mm) for grain breadth followed by Bidhan Moti 30, 15 and 17, respectively. The L/B ratio that determines the grain shape was very high in all the genotypes. Highest L/B ratio was observed in Bidhan Moti 26 (6.30) followed by Bidhan Moti 15 (6.22), Bidhan Moti 21 (6.20) and Bidhan Moti 23 (6.01), respectively. In the case of kernel length, the minimum was value recorded in Bidhan Moti 24 (7.40 mm) and maximum value in Bidhan Moti 21 (10.20 mm) followed by Bidhan Moti 3 (9.70 mm*),* Bidhan Moti 23 (9.53 mm), respectively. All the lines possessed extra long kernel (>7). A lower degree of variation was observed in kernel breadth. The minimum value was recorded by Bidhan Moti 1 (1.13 mm) and maximum value was recorded by Bidhan Moti 23 and Bidhan Moti 26 (1.46 mm). The highest kernel L/B ratio was found in Bidhan Moti 22 (8.75) followed by Bidhan Moti 3 (7.91) and Bidhan Moti 10 (7.14). Bidhan Moti 1 had the highest 1000 grain weight. Seven lines surpassed the check variety namely Satabdi (IET 4786) and Khitish (IET 4094) in respect of grain yield among these Bidhan Moti 11 possessed significantly higher yield followed by Bidhan Moti 30, 15, 6, 10, 23, respectively.

The mean, range, phenotypic, genotypic and environmental variances, genotypic coefficient of variation, heritability, genetic advance as a percentage of mean for 17 biometrical characters are presented in Table 2. The maximum range of variation in mean was observed for floret number/panicle followed by number of grains/-

Table 1. Mean performance of RILs of Basmati derivative.

Genotype	Character															
	PH	DFF	DM	NP	PW	PL	NF	NG	F%	GL	GB	GL:B	KL	KB	K L:B	GW	GY
BM-1	145.06	94.00	111.00	16.36	1.95	26.56	112.63	61.23	54.25	11.33	1.96	5.76	8.83	1.13	7.84	24.45	24.31
BM-2	102.80	92.00	114.00	17.50	1.82	26.36	125.13	74.23	59.32	9.80	1.70	5.77	7.83	1.26	6.29	18.21	23.70
BM-3	136.36	92.66	113.66	18.50	1.61	27.24	131.30	66.13	50.37	9.63	1.80	5.43	9.70	1.23	7.91	17.92	22.32
BM-5	104.96	93.33	113.66	22.93	2.06	26.70	161.16	100.60	62.41	9.73	1.80	5.74	8.50	1.23	6.89	18.55	42.80
BM-6	103.83	92.66	113.00	22.50	2.51	26.14	154.46	125.43	81.20	9.26	1.73	5.37	7.63	1.16	6.54	18.99	45.62
BM-8	119.40	94.33	116.33	17.16	1.77	23.15	126.46	77.30	61.31	8.66	1.63	5.32	7.83	1.13	6.92	19.27	26.58
BM-10	143.23	91.66	117.33	19.6	2.10	27.08	114.96	88.16	76.95	10.66	2.23	4.78	8.80	1.20	7.14	23.09	44.12
BM-11	121.30	97.33	117.00	25.26	2.82	27.50	154.53	105.93	68.99	9.33	1.70	5.50	7.70	1.23	6.80	21.17	48.21
BM-14	112.56	94.66	117.33	17.50	2.27	23.02	122.33	97.56	79.82	9.20	1.53	6.09	7.56	1.40	5.27	16.68	28.42
BM-15	126.60	93.66	115.33	18.93	2.78	26.53	149.53	118.76	79.59	9.93	1.60	6.22	7.93	1.23	6.44	21.09	47.47
BM-16	109.36	94.00	114.33	18.56	1.17	24.59	134.50	86.23	64.44	9.30	1.83	5.07	8.13	1.30	6.13	23.16	37.08
BM-17	114.20	96.66	117.00	22.36	2.29	26.49	150.93	101.63	67.14	8.93	1.60	5.59	8.06	1.13	7.12	17.63	39.97
BM-21	155.36	93.66	114.00	19.80	2.06	26.68	111.83	73.97	67.61	11.40	1.86	6.20	10.20	1.16	7.12	22.12	33.14
BM-22	120.10	98.66	113.66	16.40	2.04	26.89	203.16	96.63	47.45	9.23	1.66	5.54	8.40	1.23	8.75	15.00	23.55
BM-23	123.66	96.00	113.66	21.66	2.38	24.00	174.30	130.30	74.75	10.53	1.70	6.01	9.53	1.46	6.81	19.11	43.97
BM-24	103.00	93.66	112.33	16.00	2.46	24.70	176.23	122.50	69.51	9.36	1.73	5.40	7.40	1.30	6.50	16.97	33.28
BM-26	145.00	92.33	116.33	14.66	2.35	25.11	116.83	88.86	76.05	11.56	1.83	6.30	8.73	1.46	5.70	23.52	30.57
BM-30	126.33	96.33	114.66	24.66	1.97	22.63	138.53	93.18	67.25	8.23	1.56	5.28	9.20	1.43	5.95	20.85	47.98
Satabdi(c)	109.33	92.33	110.33	20.33	2.10	25.11	135.80	89.36	65.80	10.80	2.00	5.50	8.20	1.23	6.42	17.12	31.11
Khitish(c)	117.66	92.33	111.66	19.33	1.84	26.01	138.56	121.13	87.41	9.43	1.73	5.48	7.76	1.23	6.68	23.47	39.36
Mean	122.00	94.11	114.33	19.49	2.12	25.62	141.66	95.96	68.08	9.81	1.76	5.62	8.39	1.26	6.31	19.92	36.88
CD	1.52	2.71	2.44	1.31	0.13	1.78	1.95	2.43	1.77	0.36	0.16	0.47	0.17	0.12	0.52	2.21	11.67

PH, Plant height; NP, number of panicles/plant; NF, number of florets/plant; GL, grain length; KL, kernel length; DFF, days to 50% flowering; PW, panicle weight; NG, number of grains/plant; GB, grain breadth; KB , kernel breadth; DM, days to maturity; PL, panicle length; F%, fertility percentage; GL:B, grain length: breadth ratio; K L:B, kernel length breadth ratio; BM, Bidhanmoti; GW, 1000 grain weight; GY, grain yield/plant;

panicle, plant height and fertility percentage.

Phenotypic coefficient of variation was found to be higher than respective genotypic coefficient of variation for all the characters under study indicating the influence of environment on the expression of characters (Dutta et al., 2013). High estimates of genotypic coefficient of variation and phenotypic coefficient of variation were obtained for grain yield/ plant, number of grains/ panicle, panicle weight and floret number/ panicle which is corroborated by the results of Singh et al. (2000) and Chand et al. (2004).

High heritability was observed for most of the characters studied viz floret number/panicle, fertility percentage, kernel length, panicle weight, grain length, number of panicles/ plant, kernel L/B ratio, grain breadth and days to maturity (Bisney et al., 2009; Sao et al., 2002; Roy et al., 2001). Plant height also recorded high heritability in this regard.

Florets number/ plant recorded the maximum value for genetic advance followed by number of grains/panicle, plant height and fertility percentage. This finding corroborates earlier findings of Bisney et al. (2009) and Singh et al. (2002). Genetic advance as a percentage of mean was highest for grain yield/ plant followed by

Table 2. Variability and genetic parameters for some polygenic traits in Basmati derivatives.

Character	Range	Mean	Variances			GCV	PCV	H^2	G.A.	G.A. as % of mean
			GV	PV	EV					
Plant height (cm)	102.800-155.367	122.008	248.328	249.180	0.852	12.915	12.938	0.996	32.406	26.561
Days to 50% flowering	91.667-98.667	94.117	2.879	5.585	2.706	1.802	2.511	0.515	2.509	2.666
Days to maturity	110.333-117.333	114.333	3.658	5.840	2.182	1.672	2.113	0.626	3.117	2.727
No. of panicle/plant	14.667-25.267	19.497	8.482	9.111	0.629	14.937	15.482	0.930	5.788	29.689
Panicle wt.(gm)	1.177-2.820	2.121	0.149	0.156	0.007	18.187	18.596	0.956	0.777	36.641
Panicle length(cm)	22.630-27.50	25.627	1.848	3.011	1.163	5.305	6.771	0.613	2.194	8.563
Floret no./panicle	111.833-203.167	141.662	581.262	582.661	1.399	17.019	17.039	0.997	49.605	35.017
No of grains/panicle	61.233-130.300	95.960	495.499	407.665	2.167	20.984	21.040	0.994	41.371	43.113
Fertility %	47.450-87.417	68.083	110.751	111.909	1.158	15.457	15.537	0.989	21.56	31.676
Grain length(mm)	8.233-11.5671	9.818	0.858	0.908	0.048	9.435	9.696	0.946	1.856	18.913
Grain breadth(mm)	1.533-2.233	1.762	0.025	0.034	0.010	8.896	10.487	0.719	0.273	15.546
Grain L/B ratio	4.783-6.307	5.621	0.131	0.214	0.084	6.431	8.239	0.606	0.581	10.342
Kernel length(mm)	7.400-10.200	8.398	0.606	0.617	0.011	9.267	9.351	0.982	1.588	18.919
Kernel breadth(mm)	1.300-1.467	1.260	0.009	0.015	0.006	7.642	9.720	0.618	0.155	12.376
Kernel L/B ratio	5.277-8.753	6.724	0.592	0.692	0.101	11.438	12.374	0.854	1.464	21.781
1000 grain wt.(g)	15.000-24.450	19.921	6.902	8.700	1.797	13.188	14.806	0.793	4.820	24.198
Grain yield/plant(g)	22.320-55.367	36.882	95.580	145.44	49.86	26.507	32.699	0.657	16.326	44.266

GV, Genotypic Variance; PV, Phenotypic Variance; EV, Error Variance; GCV, Genotypic Co-efficient of Variation; PCV,Phenotypic Co-efficient of Variation; H2, Heritability; GA, Genetic Adavance;

number of grains/ panicle, panicle weight and florets number/ panicle respectively, (Nandan et al., 2010). Moderate to high heritability coupled with high genetic advance as percentage of mean was obtained for grain yield/plant, number of grains/panicle, panicle weight, number of panicles/plant and fertility percentage indicated the predominance of additive gene action for controlling these characters. Therefore, these characters could be improved simply through phenotypic selection.

Magnitude of genotypic correlation coefficients was in general higher than that of the corresponding phenotypic ones (Table 3). This findings corroborates with those of Mamun et al. (2012). Grain yield showed positive and significant correlation with fertility percentage at genotypic level and number of panicles/plant, number of grains/panicle both at genotypic and phenotypic levels. Similar findings were reported earlier by Swain and Reddy (2006), for number of panicles/plant and Senapati et al. (2009) for number of panicles/plant, number of grains/-panicle.

Therefore, these were the main yield determining characters in basmati derivatives. Plant height showed positive and highly significant correlation with grain length, kernel length, kernel L/B ratio and 1000 grain weight suggesting tall plants might be expected to produce large slender grain with more test weight. Zahid et al. (2006) also reports similar association for grain length and Sabesan et al. (2009) for 1000 grain weight.

Days to 50% flowering had positive and highly significant correlation with florets/panicle whereas significant negative correlation was observed with grain breadth. Positive significant correlation coefficients were observed for panicle weight with number of grains/panicle and fertility percentage while it had positive significant correlation coefficients with L/B ratio at genotypic level only. Panicle length incurred positive significant

Table 3. Genotypic (G) and phenotypic (P) correlation coefficient among different polygenic traits in Basmati derivatives.

Character		Days to 50% flowering	Days to maturity	No. of panicles /plant	Panicle Weight (g)	Panicle length (cm)	Floret no./ panicle	No. of grains/ panicle	Fertility %	Grain length (cm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B Ratio	1000 grain wt.(g)	Grain yield/ Plant(g)
Plant height (cm)	G	-0.074	0.182	-0.190	-0.009	0.248	-0.496*	-0.459*	-0.068	0.618**	0.437*	0.273	0.735**	-0.026	0.634**	0.601**	-0.170
	P	-0.050	0.145	-0.186	-0.010	0.200	-0.494*	-0.456*	-0.068	0.600**	0.371	0.208	0.727**	-0.016	0.588**	0.539*	-0.140
Days to 50% flowering	G		0.349	0.353	0.252	-0.111	0.680**	0.224	-0.342	-0.507*	-0.628**	0.035	0.012	0.081	0.030	-0.355	0.057
	P		0.157	0.263	0.193	-0.108	0.481*	0.141	-0.257	-0.345	-0.433*	0.028	0.009	0.123	-0.043	-0.300	-0.035
Days to maturity	G			0.108	0.251	-0.176	-0.185	-0.022	0.226	-0.259	-0.252	-0.014	-0.101	0.240	-0.159	0.054	0.045
	P			0.135	0.213	0.019	-0.150	-0.017	0.179	-0.214	-0.239	0.085	-0.070	0.027	-0.150	0.016	0.116
No of panicles/plant	G				0.268	0.067	0.202	0.342	0.199	-0.344	-0.155	-0.255	0.096	-0.045	0.159	-0.018	0.735**
	P				0.273	0.095	0.191	0.326	0.188	-0.334	-0.149	-0.161	0.082	-0.036	0.129	-0.014	0.618**
Panicle wt.(g)	G					0.173	0.325	0.603**	0.458*	0.110	-0.229	0.450*	-0.249	0.115	-0.192	-0.148	0.421
	P					0.141	0.318	0.586**	0.442*	0.088	-0.204	0.343	-0.244	0.062	-0.178	-0.131	0.353
Panicle length(cm)	G						0.085	-0.132	-0.238	0.363	0.443*	0.007	0.134	-0.654**	0.600**	0.107	0.007
	P						0.065	-0.105	-0.186	0.286	0.342	-0.038	0.079	-0.474*	0.465*	0.124	0.085
Floret no./panicle	G							0.641**	-0.142	-0.407	-0.415	-0.075	-0.234	0.111	-0.261	-0.610**	0.212
	P							0.639**	-0.142	-0.391	-0.349	-0.061	-0.231	0.080	-0.238	-0.547**	0.168
No. of grains/panicle	G								0.656**	-0.278	-0.375	0.065	-0.405	0.299	-0.541*	-0.199	0.775**
	P								0.656**	-0.269	-0.324	0.056	-0.402	0.234	-0.433*	0.312	0.637**
Fertility%	G									0.047	-0.064	0.164	-0.296	0.297	-0.463*	0.329	0.776**
	P									0.042	-0.063	0.133	-0.296	0.241	0.344	0.387	-0.201
Grain length(mm)	G										0.722**	0.477*	0.476**	0.028	0.382	0.459*	-0.244
	P										0.598**	0.410	0.462*	0.018	0.399	0.320	-0.099
Grain breadth(mm)	G											-0.259	0.339	-0.275	0.401	0.503*	-0.071
	P											-0.439*	0.290	-0.234	0.399	0.320	0.099
GrainL/B ratio	G												0.212	0.345	0.032	-0.042	-0.229
	P												0.154	0.247	-0.078	0.017	-0.113
Kernel length(mm)	G													0.159	0.701**	0.260	-0.179
	P													0.123	0.644**	0.219	-0.149
Kernel breadth (mm)	G														- 0.641**	-0.042	0.129
	P														-0.564**	0.020	-0.036
Kenel L/B ratio	G															0.241	-0.195
	P															0.181	-0.148
1000 grain wt.(g)	G																0.337
	P																0.312

* ,**, Significant at 5 and 1% level, respectively.

Table 4. Path coefficient (genotypic) analysis showing direct (bold) and indirect effects of component traits in rice.

Character	Plant height (cm)	Days to 50% flowering	Days to maturity	No. of panicles /plant	Panicle wt.(g)	Panicle length (cm)	Floret no. /panicle	No. of grains /panicle	Fertility %	Grain length (mm)	Grain breadth (mm)	L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	1000 grain wt.(g)	Genotypic yield correlation
Plant height(cm)	**2.763**	-0.010	-0.033	-0.364	0.018	0.208	0.940	-1.412	0.074	2.489	-1.379	-0.594	-1.444	-0.004	-0.567	-0.855	-0.170
Days to 50%flowering	-0.204	**0.141**	-0.064	0.675	-0.508	-0.093	-1.289	0.688	0.377	-2.040	1.982	-0.076	-0.024	0.013	-0.027	0.505	0.057
Days to maturity	0.502	0.049	**-0.184**	0.206	-0.505	0.147	0.351	-0.067	-0.249	-1.041	0.795	0.030	0.199	0.040	0.142	-0.076	0.045
No of panicle/plant	-0.526	0.050	-0.020	**1.912**	-0.538	0.056	-0.382	1.053	-0.219	-1.383	0.490	0.555	-0.188	-0.007	-0.143	0.025	0.735**
Panicle wt.(g)	-0.025	0.036	-0.046	0.512	**-2.012**	0.145	-0.617	1.856	-0.505	0.444	0.722	-0.980	0.489	0.019	0.171	0.211	0.421
Panicle length(cm)	0.686	0.016	0.032	0.128	-0.348	**0.839**	-0.160	-0.405	0.262	1.463	-1.398	-0.016	-0.264	-0.108	-0.536	-0.153	0.007
Floret no./panicle	-1.370	0.096	0.034	0.385	-0.654	0.071	**-1.896**	1.973	0.156	-1.636	1.310	0.164	0.460	0.018	0.234	0.868	0.212
No. of grains/panicle	-1.267	0.032	0.004	0.654	-1.213	-0.111	-1.216	**3.078**	-0.722	-1.118	1.183	-0.141	0.797	0.049	0.484	0.282	0.775**
Fertility %	-0.187	-0.048	-0.042	0.380	-0.922	-0.200	0.268	2.018	**-1.102**	0.187	0.201	-0.357	0.582	0.049	0.414	-0.468	0.776**
Grain length(mm)	1.709	-0.072	0.048	-0.657	-0.222	0.305	0.771	-0.855	-0.051	**4.025**	-2.279	-1.040	-0.935	0.005	-0.342	-0.653	-0.244
Grain breadth(mm)	1.206	-0.089	0.046	-0.297	0.460	0.372	0.787	-1.153	0.070	2.904	**-3.158**	0.565	-0.665	-0.046	-0.359	-0.715	-0.071
Grain L/B ratio	0.753	0.005	0.003	-0.487	-0.905	0.006	0.143	0.200	-0.180	1.922	0.819	**-2.179**	-0.417	0.057	-0.028	0.060	-0.229
Kernel length (mm)	2.031	0.002	0.019	0.183	0.501	0.113	0.444	-1.248	0.326	1.917	-1.069	-0.462	**-1.964**	0.026	-0.627	-0.370	-0.179
Kernel breadth(mm)	-0.071	0.011	-0.044	-0.085	-0.231	-0.549	-0.211	0.919	-0.327	0.113	0.870	-0.751	-0.312	**0.166**	0.572	0.060	0.129
Kernel L/B ratio	1.752	0.004	0.029	0.305	0.385	0.503	0.496	-1.665	0.511	1.540	-1.268	-0.069	-1.377	-0.106	**-0.894**	-0.342	-0.195
1000 grain wt.(g)	1.662	-0.050	-0.010	-0.034	0.299	0.090	1.157	-0.611	-0.362	1.848	-1.587	0.092	-0.512	-0.007	-0.215	**-1.422**	0.337

Residual effect = 0.18600;* ,**, Significant at 5 and 1% level, respectively.

correlation with kernel L/B ratio while it had significant negative correlation coefficient with kernel breadth.

Number of grains/ panicle had significant negative correlation coefficients with kernel L/B ratio and plant height. Grain length had positive correlationcoefficients with grain breadth, kernel length (Sabesan et al., 2009) and plant height. The kernel length had positive and highly significant correlation coefficient with kernel L/B ratio. This is similar to the result of Singh et al. (2013) and Subudhi et al. (2011). Significant negative correlation were noted for plant height with floret number per panicle and number of grain per panicle; similar relationship was also observed between days to 50% flowering and grain breadth; panicle length and kernel breadth; floret number/ panicle and 1000 grain weight; number of grains/panicle and kernel L/B ratio, kernel breadth and kernel L/B ratio. The results are in agreement with Sood and Siddiq (1980), Deosarkar and Nerkar (1994) and Christopher et al. (1999) for kernel breadth and kernel L/B ratio.

Path coefficient analysis (Table 4) revealed that the number of character chosen for the study were very much appropriate as evident from low value of residual effect (0.1860). Seven characters viz. plant height, days to 50% flowering, number of panicle/plant, panicle length, number of grains/panicle, grain length and kernel breadth had positive direct effect while nine characters namely days to maturity, panicle weight, floret number/panicle, fertility percentage, grain breadth, grain L/B ratio, kernel length, kernel L/B ratio and 1000 grain weight imparted negative direct effect on grain yield. Grain length imparted the highest positive direct effects on yield followed by number of grains/panicle, plant height, number of panicles/ plant and panicle length. It is similar with the findings of Nagesh et al. (2012), Khan et al. (2009), Mohadeseh et al. (2013) and Das et al. (2004).

Grain length and plant height incurred high positive direct effect on grain yield which was masked by their high negative indirect effects via number of grains/panicle, grain breadth, grain L/B ratio and kernel length that ultimately lead to non-significant negative correlation with yield. In this regard, a restricted simultaneous selection model is to be followed to make selection effective for plant height and grain length and restriction are to be imposed on number of grain/panicle, grain breadth, grain L/B ratio and kernel length to nullify their undesirable indirect effects on grain yield. Shanthala et al. (2004), Mahto and Yadav (2003) also reports similar results for this trait. Yield was positively correlated with number of panicle/plant, number of grain/panicle and fertility percentage. This is in agreement with the findings of Zahid et al. (2006), Asm et al. (2012) and Hasan et al. (2013). Correlation coefficient between number of panicle/plant and yield was highly significant but the direct effect was negative. This revealed that, indirect effects were mainly responsible for yielding of such correlation coefficient. Therefore, it would be effective to consider simultaneously the other characters that showed high indirect effect on grain yield, that is, number of grains/panicle, plant height and number of panicles/ plant would also be helpful for the improvement of yield in rice. Number of grains/panicle and panicle number/plant showed highly significant positive correlation simultaneous with high amount of positive direct effect on yield. These are in conformity to the findings of Mahto et al. (2003), Gazafrodi et al. (2006), Senapati et al. (2009).

Therefore, the present investigation highlighted the differential performance of the newly developed RILs. Some RILs like Bidhan Moti 6,10,11,15,23 and 30 showed very promising performance that may be useful for the development of variety in future for this areas of West Bengal. Panicle number/ plant and grain number/panicle were the prime yield contributing character in rice and their direct selection would be effective in yield improvement in rice.

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