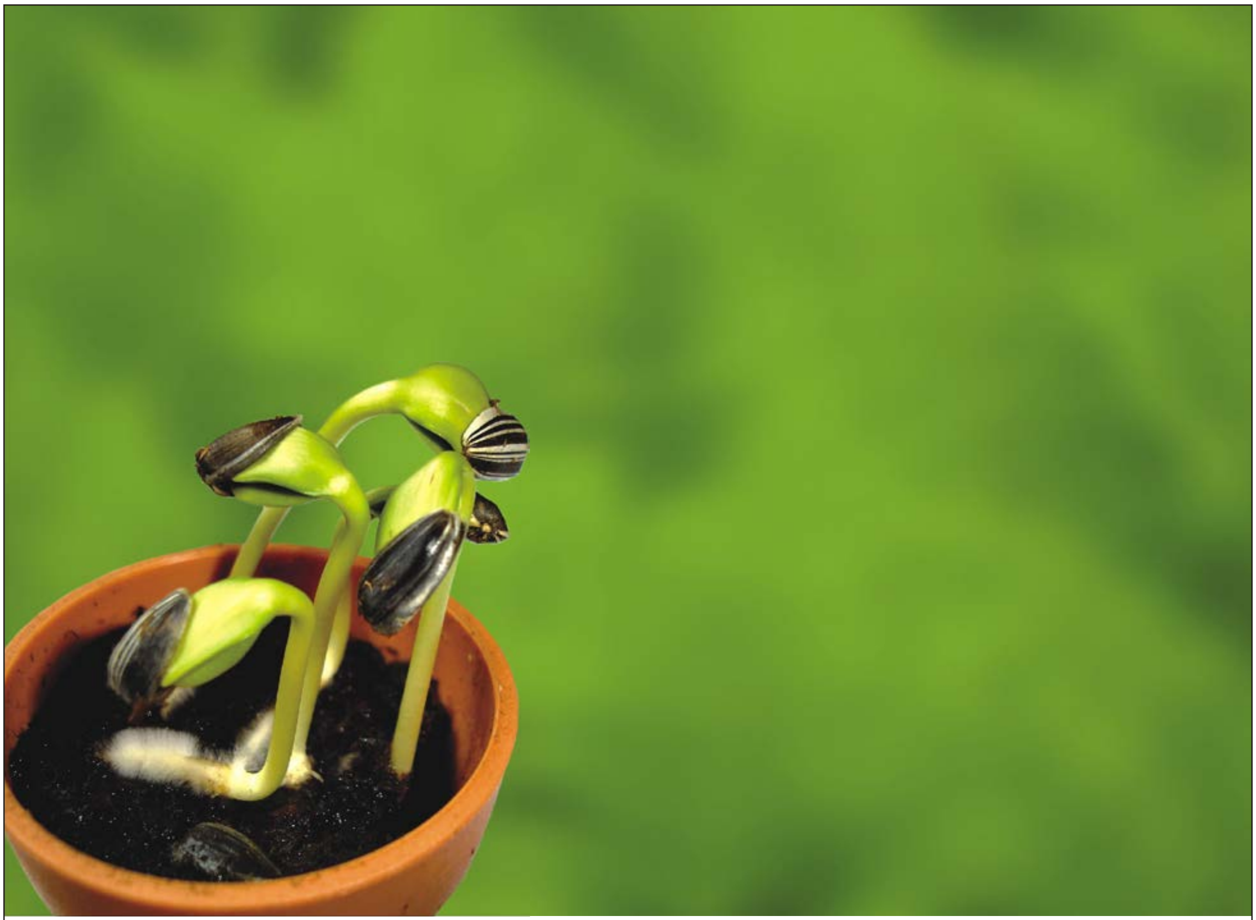

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Morpho-Physicochemical Characterization of Balam Rice (*Oryza sativa* L.) Land races of Bangladesh

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ABSTRACT

In total 40 land races of Balam rice of Bangladesh were studied at BRRI during 2009-11. The analysis of variance of 38 morpho-physicochemical characters showed highly significant differences among the genotypes. The mean performances showed high degree of variations among the genotypes. The culm height varied from 61.5 (B31) to 137.26 cm (B11), effective tiller number per hill from 6.33 (B34) to 24.67 (B30), straw yield per hill from 8.44 (B21) to 57.93 g (B39), primary branch number from 6.33 (B21) to 14.33 (B17), secondary branch number from 11 (B26) to 50 (B29), grain length from 6.43 (B33) to 10.83 mm (B8), 1000-grain weight from 16.44 (B32) to 33.22 g (B39) and grain yield per hill from 8.47 (B26) to 33.31 g (B17), respectively. The mean separations showed that no single duplicate genotype was present in the land races. Besides, high GCV and h^2_b together with high GAPM were observed in culm height, 1000-grain weight, LB ratio, panicle exertion, secondary branch number, plant height etc. suggested that selection may be effective for these characters in segregating generations. In correlation coefficients between different characters, 63 correlation coefficients were positive in nature and only 10 estimates were negative. This represents very highly favorable situation for obtaining high response to selection in improving yield and yield components in rice germplasm evaluated. Therefore, these characters emerged as most important associates of grain yield in rice. Finally, the traditional rice germplasm can offer valuable gene pools, which need to be characterized by using molecular tools for QTL mapping of valuable traits.

Key words: Morpho-physicochemical characters, balam rice land races, Bangladesh

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for nearly half of the global population especially in Asia, Africa and Latin America. Over 90% of the world's rice is produced in Asia. Bangladesh is one of the largest producer and consumer of rice in the world with an annual production of 33.88 million m t by occupying 77.15% of the total cropped area of the country (BBS., 2013). Presently, Bangladesh is self sufficient for rice production. However, the increased demand for rice will have to meet in the context of shrinking rice land and water resources in future. Moreover, climate change has negative impact on rice production. Therefore, the new novel and diverse genes that govern biotic and abiotic stresses and the new quality traits with indigenous or traditional values may be considered in parental selection for future rice variety development.

Rice germplasm is not only endowed with genetic diversity but also represents a wealth of valuable genes. The rice germplasm is a rich reservoir of valuable genes that Plant breeders can harness for crop improvement (Yadav *et al.*, 2013). Exploring diversity in a land race collection is very important for identifying new genes and further improvement of the germplasm (Thomson *et al.*, 2007). Local and traditional land races of rice are now replacing with the Modem Varieties (MVs) in Bangladesh. Besides, various interventions of rice habitat and different environment hazard development are occurring due to over population of the country. Therefore, rice land races need to be utilized in developing new varieties for maintaining rice gene diversity in rice-ecosystem.

The rice germplasm with duplicate and similar names need to be characterized for their effective conservation and utilization. But little work has been done on the detail characterization of duplicate and similar named rice land races of Bangladesh. The present study was, therefore, undertaken to assess the variability of 40 land races of Balam rice with duplicate and similar names of Bangladesh for identifying potential genotypes.

MATERIALS AND METHODS

Experimental site and materials: The field experiments were conducted at the research plots of Bangladesh Rice Research Institute (BRRI), Gazipur during 2009-2011 and the physico-chemical properties were estimated in the laboratories of Grain Quality and Nutrition Division (GQND) of the same during 2011. A total of 40 land races of Balam rice of Bangladesh were used in the experiments (Table 1), which were collected from Genebank of BRRI at Gazipur.

Experimental design: The thirty days old single seedling was transplanted per hill for each genotype in Randomized Complete Block Design (RCBD) with three replications. Spaces within and between rows were 20 and 25 cm, respectively. The unit plot for each genotype had 4 rows each 2.7 m long. The chemical fertilizer dose of 60-50-40-10 kg NPKS per hectare was applied in the form of Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP) and Gypsum respectively. Total quantity of TSP, MP and Gypsum were applied at the final land preparation. Urea was applied in three installments at 15, 30 and 45 Days After Transplanting (DAT).

Data analysis: The data of the morpho-physiocochemical characters were statistically analyzed by computer using MstatC software. For each character, the mean and range were calculated and ANOVA (Analysis of Variance) was performed. The mean values were separated by Duncan's Multiple Range Test (DMRT) as suggested by Stell and Torrie (1960). The error MS was considered as error variance (σ^2e). The genotypic variance (σ^2g), phenotypic variance (σ^2p) and heritability (h^2_b%) in broad sense were estimated as suggested by Johnson *et al.* (1955), while the Genotypic Coefficient of Variation (GCV %) and Phenotypic Coefficient of Variation (PCV %) by the formula as suggested by Burton (1952). Moreover, the Genetic Advance (GA) was estimated according to Lush (1949) and Johnson *et al.* (1955), the Genetic Advance in Percent Mean (GAPM) by Comstock and Robinson (1952) and the simple correlation coefficients by Beale (1969).

Table 1: Alphabetical list of 40 Balam rice with BRRI accession number

			Place of collection			
Local name	Code name	Accession number	Thana	District	Date of collection	Growing season
Balam	B1	1430	Dhaka	Dhaka	15.12.74	T. Aman
Balam	B2	995	Phultala	Khulna	14.12.73	Aus
Balam	B3	516	Kurigram	Rangpur	16.01.74	T. Aman
Balam	B4	841	Balagonj	Sylhet	17.12.73	Aus
Balam	B5	4050	Srimongol	M. Bazar	Nov.,1988	T. Aman
Balam	B6	692	B. Baria	Comilla	29/12/73	T. Aman
Balam	B7	853	Phultala	Khulna	13.12.73	Aus
Balam	B8	3643	Sherpur/Iswardi	Sherpur/pabna	27/10/86	T. Aman
Balam	B9	843	Tajpur	Sylhet	02/12/73	T. Aman
Balam	B10	3516	Baraigran	Rajshahi	14-06-86	Aus
Balam	B11	683	B. Baria	Comilla	21.03.74	T. Aman
Balam	B12	720	Hajigong	Comilla	01.01.74	B. Aman
Balam	B13	855	Biswanath	Sylhet	11.5.74	Aus
Balam	B14	4045	-	Kustia	1987	Aus
Balam	B15	842	CH. Ghat	Sylhet	13/12/73	T. Aman
Balam	B16	823	Daulatpur	Sylhet	05/12/73	T. Aman
Balam	B17	1013	Kochoa	Khulna	11.12.73	T. Aman
Balam	B18	839	Beaurbazar	Sylhet	01.01.73	Aus
Banaful balam	B19	4164	Sadar	Jessor	Dec. 88	T. Aman
Baulam	B20	3565	Nalchiti	Barisal	08-07-86	Aus
Baulam	B21	3730	Najirpur	Barisal	27-10-86	Aus
Beti balam	B22	1011	Kochoa	Khulna	11.12.73	T. Aman
Bhua balam	B23	878	Gol Pgorw	Sylhet	08.03.74	T. Aman
Boilam	B24	3538	Sonagazi	Noakhali	14-06-86	Aus
Boilam	B25	4608	Noakhali sadar	Noakhali	Dec'95	Aus
Boislam	B26	3201	Tejgoan	Dhaka	21.02.83	Aus
Boislam	B27	3497	Shitakundu	Chitta gong	10-03-86	Aus
Bola balam	B28	4836	Shympur	Satkhira	Oct.,1997	T. Aman
Jesso balam	B29	2456	PBD, BRRI	Gazipur	10.12.82	T. Aman
Kabra balam	B30	240	Trisal	Mymensingh	01.05.74	T. Aman
Kartik balam	B31	696	Faridgonj	Comilla	17.05.74	B. Aman
Khud balam	B32	3668	Jhenagali	Sherpur	27.10.86	T. Aman
Khud balam	B33	2089	Jamalpur	Jamalpur	13.08.78	Aus
Lal balam	B34	2115	Narshindi	Dhaka	24.08.78	Aus
Lona balam	B35	4789	Shympur	Satkhira	Oct. 97	T. Aman
Makai balam	B36	4158	Kulawra	M. Bazar	Dec. 88	T. Aman
Mogai balam	B37	965	Fakirhat	Khulna	06.12.73	Aus
Murki balam	B38	771	Bansakhali	Chittagong	11.12.73	T. Aman
Patni balam	B39	4838	Shympur	Satkhira	Oct.97	T. Aman
Samriti balam	B40	3670	Jamalpur	Jamalpur	27.10.86	T. Aman

BRRI rice genebank accession number

RESULTS AND DISCUSSION

Analysis of variance of morpho-physicochemical characters: The analysis of variance of 38 morpho-physicochemical characters; in which 31 morpho-physiological and seven physico-chemical characters, showed highly significant differences ($p<0.01$) among the genotypes of 40 land races of Balam rice for all characters (Table 2).

It indicated the existence of wide range of genetic variations among the genotypes. Previously, Pandey *et al.* (2009) reported highly significant difference among 40 genotypes of rice for 12 quantitative traits. Sohrabi *et al.* (2012) evaluated 50 Malaysian upland rice accessions for 12 growth, yield and yield component traits and observed significant and highly significant deference among the accessions for all the traits. Therefore, means of 38 morpho-physicochemical characters need to be separated as wide range of genetic variations was existed among the land races.

Table 2: Mean Sum of Square (MSS) of 38 morpho-physicochemical characters of 40 Balam rice

Characters	Replication	Variety	Error
Coleoptile length (mm)	0.07	6.21**	0.72
Seedling height (cm)	45.76	156.68**	2.51
Penultimate leaf length (cm)	24.79	65.19**	10.73
Penultimate leaf width (mm)	0.30	5.91**	0.41
Penultimate leaf area (cm^2)	35.06	161.16**	14.83
Flag leaf length (cm)	12.60	35.05**	11.59
Flag leaf width (mm)	0.52	7.31**	0.52
Flag leaf area (cm^2)	16.62	65.80**	18.62
Culm height (cm)	87.35	978.26**	29.47
Culm diameter (mm)	0.10	1.81**	0.10
Plant height (cm)	134.76	1090.83**	31.60
Panicle exertion (cm)	0.61	7.11**	0.60
Effective tiller number per hill	4.01	57.39**	12.29
Straw yield per hill (g)	63.99	353.31**	28.19
Days to maturity	13.01	293.01**	0.01
Panicle length (cm)	5.56	9.86**	0.79
Grain yield per panicle (g)	0.31	2.40**	0.27
Grain yield per hill (g)	144.44	159.58**	17.67
Harvest index (HI) (%)	71.80	129.29**	24.25
Biological yield (BY) (g)	50.32	922.09**	82.37
Primary branch number	0.11	15.76**	1.72
Av. primary branch length (cm)	0.28	3.01**	0.47
Filled grain number per primary branch	0.15	0.48**	0.19
Primary branch filled grain weight (g)	0.01	0.56**	0.06
Secondary branch number	128.36	346.26**	19.17
Av. secondary branch length (mm)	6.46	22.09**	3.64
Filled grain number per secondary branch	0.07	0.41**	0.10
Secondary branch filled grain weight (g)	0.30	0.84**	0.17
Grain length (mm)	0.06	1.75**	0.03
LB ratio	0.03	0.83**	0.01
1000-grain weight (g)	1.60	46.94**	1.11
Milling outturn (%)	11.58	9.77**	0.93
Head rice outturn (%)	158.01	774.80**	0.52
Cooking time (min)	29.45	13.04**	0.31
Elongation ratio	0.10	0.03**	0.01
Imbibition ratio	0.06	0.30**	0.03
Amylose content (%)	7.10	10.72**	0.05
Protein content (%)	2.23	5.48**	0.01

**: Significant at 1% level of probability

Extent of variability of balam rice: The mean performance results of 40 land races of Balam rice for 38 morpho-physiochemical characters also showed that high degree of genetic variations existed in the studied germplasm (Table 3-6). For example: seedling height had the mean value of 61.92 cm with a wide range from 43.78 cm (B31) to 74.01 cm (B28). Similarly, penultimate leaf length with a mean value of 50.52 cm, varied from 41.21 (B33) to 63.56 cm (B29), penultimate leaf area with a mean value of 43.83 cm^2, varied from 31.75 (B9) to 65.96 cm^2 (B18), culm height with mean 100.91 cm varied from 61.5 (B31) to 137.26 cm (B11), respectively. Again, plant height with mean 125.49 cm varied from 87.87 (B31) to 161.97 cm (B11), effective tiller number per hill with mean 15.29 varied from 6.33 (B34) to 24.67 (B30), straw yield per hill with mean 28.06 g varied from 8.44 (B21) to 57.93 g (B39), days to maturity with mean 141.13 varied from 126 (B19) to 156 (B38), respectively. On the other hand, panicle length with a mean value of 24.58 cm varied from 20.3 (B26) to 27.38 cm (B22), grain yield per panicle with mean 2.74 g varied from 1.04 (B26) to 4.96 g (B17), grain yield per hill with mean 22.27 g varied from 8.47 (B26) to 33.31 g (B17), harvest index with mean 40.93% varied from 25.93 (B19) to 50.8% (B32) and biological yield with mean 47.57 g varied from 14.23 (B26) to 96.39 g (B39), respectively. Besides, primary branch number

Table 3: Mean performance of seedling, leaf and culm characters of 40 Balam rice

Genotypes	Coleoptile length (mm)	Seedling height (cm)	Penultimate leaf length (cm)	Penultimate leaf width (mm)	Penultimate leaf area (cm^2)	Flag leaf length (cm)	Flag leaf width (mm)	Flag leaf area (cm^2)	Culm height (cm)	Culm diameter (mm)
B1	8.89^{ln}	54.89^{lm}	51.03^{ci}	11.73^{dk}	44.87^{fj}	34.75^{cj}	14.77^{ch}	38.49^{ch}	111.91^{dh}	5.43^{fi}
B2	9.84^{hm}	55.38^{km}	50.16^{dj}	11.05^{hm}	41.57^{hk}	33.07^{gj}	13.6^{gn}	33.71^{ei}	96.89^{jl}	5.42^{fi}
B3	9.64^{in}	53.09^{mn}	56.26^{bc}	12.8^{be}	54.05^{bd}	37.7^{ah}	15.37^{bf}	43.45^{bc}	122.45^{bc}	6.06^{ce}
B4	12.03^{be}	60.19^{hj}	54.54^{be}	11.13^{hm}	45.56^{fi}	37.98^{ag}	13.83^{gn}	39.42^{cg}	107.73^{gi}	5.65^{eg}
B5	11.61^{bg}	62.27^{gh}	59.53^{ab}	10.8^{im}	48.39^{dh}	41.69^{ab}	13.33^{ho}	41.8^{be}	120.04^{be}	5.47^{fi}
B6	10.33^{el}	60.40^{gj}	49.20^{ej}	10.53^{km}	38.88^{il}	36.74^{ai}	13.33^{ho}	36.75^{ci}	100.44^{ik}	5.29^{fj}
B7	12.28^{bc}	70.33^{be}	55.83^{bd}	10.07^{lm}	42.13^{gk}	41.67^{ab}	12.43^{no}	38.84^{ch}	90.44^{kn}	4.95^{im}
B8	11.53^{bg}	70.57^{be}	52.04^{cg}	10.93^{hm}	42.68^{gk}	33.7^{ej}	13.47^{ho}	34.05^{ei}	118.78^{bf}	5.87^{df}
B9	10.92^{ck}	54.90^{lm}	41.22^{l}	10.27^{lm}	31.75^{l}	35.26^{bj}	13.23^{io}	34.98^{ci}	78.67^{oq}	4.59^{ko}
B10	11.25^{ci}	61.27^{gi}	48.39^{ek}	9.9^{m}	35.99^{kl}	35.12^{bj}	12.07^{o}	31.9^{gi}	97.47^{jl}	5.12^{gl}
B11	10.11^{gm}	63.27^{g}	51.83^{ch}	13.27^{b}	51.53^{cf}	32.83^{gj}	15.73^{bc}	38.71^{ch}	137.26^{a}	6.46^{bc}
B12	10.58^{dk}	58.17^{jk}	54.54^{be}	12.07^{bh}	49.37^{cg}	32.1^{gj}	14.77^{ch}	35.57^{ci}	110.73^{eh}	5.62^{eg}
B13	10.67^{ck}	56.8^{kl}	52.36^{cf}	11.27^{gl}	44.53^{fj}	39.81^{af}	14.17^{dl}	0.43^{bd}	92.29^{jn}	4.98^{hm}
B14	9.42^{jn}	57.99^{jk}	46.86^{fl}	10.33^{lm}	36.31^{kl}	35.52^{bj}	12.93^{ko}	34.45^{di}	86.57^{mo}	4.68^{ko}
B15	10.89^{ck}	60.33^{gj}	49.81^{cj}	10.3^{lm}	38.52^{il}	35.62^{bj}	12.7^{mo}	33.91^{ei}	93.09^{jm}	5.32^{fj}
B16	10.22^{fm}	54.86^{lm}	44.55^{il}	10.73^{jm}	35.86^{kl}	40.55^{ae}	13.53^{gn}	41.17^{bf}	76.4^{pq}	4.88^{im}
B17	11.11^{cj}	61.25^{gi}	52.07^{cg}	15.43^{a}	60.25^{ab}	34.13^{ej}	18.8^{a}	48.17^{ab}	109.1^{fi}	6.88^{b}
B18	11.39^{bh}	67.72^{ef}	54.02^{be}	16.27^{a}	65.96^{a}	36.1^{bj}	19.53^{a}	52.97^{a}	117.37^{bg}	7.57^{a}
B19	0.12^{be}	66.88^{f}	49.44^{dj}	10.85^{hm}	40.23^{ik}	41.03^{ad}	14.1^{em}	43.36^{bc}	90.68^{kn}	4.67^{ko}
B20	10.44^{dl}	58.33^{ik}	50.04^{cj}	11.1^{hm}	41.71^{hk}	38.89^{ag}	13.87^{gn}	40.4^{bg}	89.93^{ln}	4.86^{im}
B21	9.25^{kn}	60.62^{gj}	45.59^{gl}	10.67^{jm}	36.47^{kl}	35.65^{bj}	13.57^{gn}	36.29^{ci}	86.88^{mo}	4.54^{lo}
B22	12.97^{b}	67.70^{df}	48.61^{ek}	12.97^{bd}	46.02^{ei}	41.55^{ac}	13.87^{gn}	42.41^{be}	121.37^{bd}	6.42^{bd}
B23	10.25^{fl}	61.87^{gh}	51.13^{ch}	11.73^{ek}	45.01^{fj}	35.84^{bj}	14.6^{cj}	39.25^{ch}	113.87^{cg}	6.07^{ce}
B24	11.86^{bf}	68.25^{cf}	51.82^{ch}	10.17^{lm}	39.51^{ik}	41.54^{ac}	12.93^{ko}	40.34^{bg}	81.99^{nq}	4.63^{ko}
B25	11.67^{bg}	65.99^{f}	51.88^{ch}	10.13^{lm}	39.43^{ik}	41.72^{ab}	12.73^{lo}	39.81^{bg}	83.81^{mp}	4.27^{no}
B26	9.47^{jn}	57.07^{kl}	43.72^{jl}	0.12^{ci}	39.46^{ik}	36.34^{aj}	14.23^{dk}	38.93^{ch}	77.63^{oq}	4.14^{o}
B27	10.22^{fm}	66.59^{f}	52.65^{cf}	10.2^{lm}	40.30^{ik}	43.02^{a}	12.93^{ko}	41.73^{be}	84.75^{mp}	4.67^{ko}
B28	11.78^{bg}	74.01^{a}	50.50^{ci}	10.6^{jm}	40.19^{ik}	29.53^{j}	13.17^{jo}	29.17^{i}	113.94^{cg}	4.77^{jn}
B29	9.69^{hm}	57.25^{kl}	63.56^{a}	11.8^{dj}	56.22^{bc}	36.31^{aj}	14.02^{fm}	38.22^{ch}	114.16^{cg}	5.88^{df}
B30	10.56^{dl}	62.57^{gh}	48.95^{ek}	10.47^{lm}	38.48^{il}	34.69^{dj}	13.37^{ho}	34.84^{ci}	109.99^{ei}	5.19^{gk}
B31	9.5^{jn}	43.78^{o}	42.79^{kl}	11.13^{hm}	35.78^{kl}	36.67^{ai}	13.87^{gn}	38.19^{ch}	61.5^{r}	5.56^{eh}
B32	8.06^{n}	62.19^{gh}	52.16^{cg}	10.4^{lm}	40.68^{ik}	34.13^{ej}	12.73^{lo}	32.64^{fi}	102.26^{hj}	5.32^{fj}
B33	6.28^{o}	45.66^{o}	41.21^{l}	11.33^{fl}	35.08^{kl}	33.67^{ej}	14.67^{ci}	37.1^{ci}	72.1^{q}	4.39^{mo}
B34	8.58^{mn}	50.59^{n}	45.62^{gl}	13.17^{bc}	45.07^{fj}	34.91^{bj}	16.6^{b}	43.47^{bc}	72.82^{q}	4.73^{jo}
B35	10.83^{ck}	72.51^{ab}	45.44^{hl}	11.07^{hm}	37.74^{jl}	30.86^{hj}	13.23^{io}	30.64^{hi}	93.89^{jm}	5.01^{hl}
B36	10.39^{dl}	70.48^{be}	50.36^{ci}	13.23^{b}	50.29^{cf}	33.79^{ej}	16.4^{b}	41.69^{be}	112.99^{cg}	5.81^{ef}
B37	14.75^{a}	70.23^{be}	53.83^{be}	12.07^{bh}	48.73^{dh}	34.23^{dj}	14.9^{cg}	38.28^{ch}	120.13^{be}	5.4^{fi}
B38	12.08^{bd}	70.72^{bd}	53.42^{bf}	12.53^{bf}	50.21^{cf}	33.14^{fj}	15.53^{bd}	38.6^{ch}	127.47^{b}	6.69^{b}
B39	0.11^{cj}	70.85^{bc}	55.85^{bd}	12.63^{be}	52.99^{ce}	37.4^{ai}	15.43^{be}	43.35^{bc}	127.17^{b}	6.64^{b}
B40	10.39^{dl}	68.74^{cf}	48.63^{ek}	12.47^{bg}	45.45^{fi}	30.74^{ij}	14.6^{cj}	33.69^{ei}	108.36^{fi}	5.58^{eh}
Mean	10.62	61.92	50.52	11.54	43.83	36.25	14.23	38.60	100.91	5.39

In column, means followed by a common small letter are not statistically different at the 5% level by DMRT

with mean 10.57 varied from 6.33 (B21) to 14.33 (B17), average primary branch length with mean 10.87 cm varied from 9.06 (B11/B26) to 12.99 cm (B31), secondary branch number with mean 30.52 varied from 11 (B26) to 50 (B29) and average secondary branch length with mean 24.98 mm varied from 18.96 (B32) to 30.62 mm (B5), respectively. Last but not the least, grain length having a mean value of 8.48 mm, showed a wide range of variation from 6.43 (B33) to 10.83 mm (B8), 1000-grain weight with mean 23 g varied from 16.44 (B32) to 33.22 g (B39), milling outturn with mean 69.36%, varied from 63 (B19) to 73% (B14), head rice outturn with mean 83.13% varied from 33 (B18) to 99% (B16), amylose content with mean 22.51% varied from 16 (B1) to 25.9% (B14) and protein content with mean 9.13% varied from 5.6 (B4) to 12.4% (B2), respectively. Therefore, the mean result revealed that there were ample scope existed to select and utilize of different quantitative characters for varietal development programs.

Table 4: Mean performance of morpho-physiological characters of 40 Balam rice

Genotypes	Plant height (cm)	Panicle exertion (cm)	Effective tiller number per hill	Straw yield per hill (g)	Days to maturity	Panicle length (cm)	Grain yield per panicle (g)	Grain yield per hill (g)	Harvest index (HI)	Biological yield (BY)
B1	137.67^{df}	5.91^{c}	17.67^{bj}	31.12^{dg}	139^{n}	25.77^{ag}	3.19^{di}	26.45^{ad}	44.34^{aj}	56.09^{ce}
B2	120.01^{hi}	2.42^{kr}	15.5^{cj}	25.7^{fi}	142^{m}	23.12^{jo}	2.57^{fn}	23.99^{bf}	44.56^{aj}	46.91^{dh}
B3	148.19^{bd}	7.62^{b}	13.67^{gm}	35.54^{cf}	152^{e}	25.74^{ag}	3.19^{di}	24.34^{bf}	34.61^{jo}	54.29^{ce}
B4	134.87^{eg}	2.15^{mr}	15.33^{el}	29.63^{dg}	143^{l}	27.13^{ab}	3.75^{ce}	27.38^{ac}	49.46^{ad}	58.45^{ce}
B5	145.41^{be}	4.2^{di}	0.20^{ag}	32.35^{cg}	136^{p}	25.38^{ci}	2.63^{fm}	16.66^{fh}	33.81^{ko}	48.78^{cg}
B6	125.58^{gh}	1.74^{qr}	21.67^{ae}	29.96^{dg}	145^{k}	25.14^{cj}	2.4^{gn}	25.3^{ae}	42.52^{ak}	51.66^{cf}
B7	115.29^{hk}	3.93^{dj}	22.33^{ad}	27.57^{eh}	136^{p}	24.85^{ek}	2.3^{in}	26.01^{ae}	47.58^{ae}	52.82^{ce}
B8	144.17^{bf}	3.38^{fp}	18.0^{ai}	35.72^{cf}	149^{i}	25.4^{ci}	3.34^{dh}	30.39^{ab}	42.57^{ak}	63.71^{bd}
B9	100.33^{ln}	3.3^{gp}	11.67^{in}	12.41^{k}	131^{r}	21.66^{pq}	1.81^{lo}	9.99^{hi}	39.71^{dl}	20.41^{ij}
B10	120.92^{hi}	1.86^{pr}	24.0^{ab}	30.17^{dg}	142^{m}	23.46^{jo}	2.37^{hn}	0.29^{ab}	45.69^{ag}	55.76^{ce}
B11	161.97^{a}	9.02^{a}	0.11^{in}	36.20^{cf}	151^{g}	24.71^{ek}	3.42^{dg}	25.43^{ae}	35.42^{hn}	55.99^{ce}
B12	137.01^{ef}	2.22^{lr}	0.19^{ah}	34.65^{cg}	155^{b}	26.28^{af}	2.54^{fn}	30.15^{ab}	43.67^{aj}	61.52^{ce}
B13	114.6^{ik}	3.38^{fp}	17.0^{cj}	35.29^{cf}	139^{n}	22.31^{mp}	2.27^{in}	13.5^{gi}	28.97^{mo}	49.89^{cg}
B14	111.61^{ik}	4.81^{cg}	18.0^{ai}	18.39^{hk}	129^{t}	25.04^{dj}	2.25^{in}	18.65^{dg}	46.2^{af}	34.13^{fi}
B15	119.52^{hi}	3.82^{dk}	16.33^{ck}	26.33^{fi}	137^{o}	26.43^{ae}	2.8^{el}	25.93^{ae}	49.81^{ac}	52.66^{ce}
B16	100.1^{ln}	4.44^{ch}	15.67^{dl}	16.73^{ik}	130^{s}	23.69^{in}	1.84^{ko}	14.85^{gi}	50.15^{ab}	33.67^{gi}
B17	136.34^{ef}	3.53^{en}	8.67^{ln}	35.31^{cf}	151^{g}	27.24^{ab}	4.96^{a}	33.31^{a}	42.29^{ak}	61.37^{ce}
B18	144.79^{bf}	3.43^{fn}	8.0^{mn}	33.52^{cg}	153^{d}	27.42^{a}	4.81^{ab}	29.23^{ab}	43.05^{ak}	58.36^{ce}
B19	116.81^{hj}	3.29^{gp}	13.0^{gn}	32.72^{cg}	126^{v}	26.13^{af}	1.89^{ko}	20.24^{cg}	25.93^{o}	44.2^{eh}
B20	112.61^{ik}	2.81^{iq}	14.33^{fm}	14.79^{jk}	128^{u}	22.68^{lp}	2.11^{jn}	18.1^{eg}	39.6^{el}	24.64^{ij}
B21	108.72^{jl}	5.14^{cd}	9.67^{kn}	8.44^{k}	137^{o}	21.84^{oq}	1.83^{lo}	8.51^{i}	47.87^{ae}	15.5^{j}
B22	148.75^{bc}	3.74^{dl}	16.0^{ck}	48.61^{b}	155^{b}	27.38^{a}	3.77^{ce}	0.31^{ab}	38.62^{el}	78.8^{b}
B23	138.58^{cf}	2.49^{jr}	14.33^{fm}	35.1^{cf}	151^{g}	24.72^{ek}	2.87^{ek}	26.79^{ad}	36.8^{fm}	55.64^{ce}
B24	105.27^{km}	3.04^{hq}	15.33^{el}	15.49^{jk}	129^{t}	23.28^{kp}	2.27^{in}	14.84^{gi}	49.65^{ac}	30.74^{hj}
B25	107.74^{jm}	2.05^{nr}	11.33^{in}	12.55^{k}	137^{o}	23.93^{hm}	1.82^{lo}	14.04^{gi}	44.59^{ai}	22.82^{ij}
B26	97.93^{mn}	4.73^{cg}	10.67^{jn}	8.7^{k}	128^{u}	20.3^{q}	1.04^{o}	8.47^{i}	39.38^{el}	14.23^{j}
B27	108.57^{jl}	2.55^{jr}	12.33^{hn}	14.95^{jk}	129^{t}	23.82^{im}	1.91^{ko}	12.92^{gi}	45.05^{ah}	27.23^{ij}
B28	139.57^{cf}	4.36^{dh}	22.67^{ac}	38.87^{cd}	151^{g}	25.63^{bh}	3.41^{dg}	31.16^{ab}	40.51^{bl}	65.67^{bc}
B29	140.97^{cf}	4.28^{di}	15.0^{em}	37.12^{ce}	151^{f}	26.8^{ac}	3.12^{dj}	26.4^{ad}	36.04^{gn}	58.75^{ce}
B30	136.64^{ef}	4.72^{cg}	24.67^{a}	26.73^{ei}	153^{d}	26.65^{ad}	2.22^{in}	23.15^{bf}	40.26^{cl}	44.88^{eh}
B31	87.87^{o}	4.62^{cg}	13.0^{gn}	30.44^{dg}	135^{q}	26.36^{ae}	2.78^{el}	16.63^{fh}	33.5^{ko}	45.79^{dh}
B32	125.73^{gh}	1.28^{r}	21.0^{af}	24.32^{gj}	146^{j}	23.47^{jo}	2.96^{ej}	26.63^{ad}	50.8^{a}	49.32^{cg}
B33	93.81^{no}	4.87^{cf}	9.67^{kn}	16.23^{jk}	128^{u}	21.71^{pq}	1.63^{mo}	8.59^{hi}	32.34^{lo}	23.67^{ij}
B34	94.84^{no}	3.54^{en}	6.33^{n}	14.31^{jk}	129^{t}	22.02^{np}	1.55^{no}	0.13^{gi}	27.22^{no}	19.67^{ij}
B35	116.69^{hj}	4.52^{ch}	13.67^{gm}	24.42^{gj}	130^{s}	22.8^{lp}	2.46^{fn}	24.07^{bf}	50.21^{ab}	49.62^{cg}
B36	136.19^{ef}	5.05^{ce}	14.33^{fm}	29.4^{dg}	150^{h}	23.2^{kp}	3.43^{dg}	23.74^{bf}	34.91^{io}	45.28^{eh}
B37	144.69^{bf}	2.34^{kr}	16.0^{ck}	35.29^{cf}	154^{c}	24.57^{fk}	2.29^{in}	26.11^{ae}	38.02^{em}	56.96^{ce}
B38	151.64^{b}	3.41^{fo}	15.33^{el}	42.58^{bc}	156^{a}	24.17^{gl}	3.48^{cf}	27.1^{ac}	35.78^{hn}	65.68^{bc}
B39	152.35^{b}	1.9^{or}	14.67^{fm}	57.93^{a}	152^{e}	25.18^{cj}	4.41^{ac}	33.21^{a}	0.39^{el}	96.39^{a}
B40	133.91^{fg}	3.67^{dm}	13.33^{gm}	26.56^{ei}	143^{l}	25.55^{bh}	4.03^{bd}	26.32^{ae}	47.23^{ae}	50.63^{cg}
Mean	125.49	3.74	15.29	28.06	141.13	24.58	2.74	22.27	40.93	47.57

In column, means followed by a common small letter are not statistically different at the 5% level by dMRT

Earlier, Parikh *et al.* (2012) characterized 71 aromatic rice germplasm and found the highest plant height, panicle length, hundred seed weight and head rice recovery as 146.05 cm, 26.9 cm, 2.99 g and 73.7%, respectively by evaluating 22 morphological and agronomical traits. Chakravorty *et al.* (2013) observed the highest leaf length as 61.0 cm, leaf breadth as 2.20 cm, plant height as 43.0 cm, days to maturity as 172 days, panicle length as 30.50 cm, primary branch per panicle as 16, grain length as 11.2 mm, 1000-grain weight as 29.91 g and grain per panicle as 334 etc. in 51 rice land races of West Bengal. Thus, the germplasm with desirable characteristics and high potentiality can be utilized for developing variety.

Again, Biswas *et al.* (2001) studied some Binni rice varieties and found the highest grain length as 6.2 mm, L/B ratio as 3.2 and 1000-grain weight as 25 g, milling outturn as 71%, head rice outturn as 97%, amylose as 26.9% and protein content as 10.5%, respectively. But Subudhi *et al.* (2012) evaluated 41 rice varieties of different ecologies and found the highest milling recovery, head

Table 5: Mean performance of Primary Branch (PB) and Secondary Branch (SB) characters of 40 Balam rice

Genotypes	PB number	Av. PB length (cm)	Filled grain number per PB	PB filled grain weight (g)	SB number	Av. SB length (mm)	Filled grain number per SB	SB filled grain weight (g)
B1	12^{ae}	11.2^{bh}	4.75^{bi}	1.19^{fj}	39.33^{bf}	24.33^{dk}	2.8^{af}	2.01^{bd}
B2	11^{dh}	10.35^{bi}	4.93^{di}	1.48^{fi}	26.5^{hm}	24.03^{dk}	2.33^{fj}	1.09^{ek}
B3	13.67^{ac}	10.95^{di}	4.86^{bh}	1.16^{gj}	46.67^{ab}	26.66^{bh}	2.98^{ad}	2.04^{bc}
B4	12^{ae}	12.99^{a}	4.93^{bh}	1.54^{dg}	45^{ad}	26.36^{bi}	2.22^{fj}	2.21^{ab}
B5	11^{dg}	12.36^{ab}	5.43^{ae}	1.25^{fj}	31^{fk}	30.62^{a}	2.16^{fj}	1.37^{cj}
B6	11.67^{be}	10.4^{ek}	4.58^{di}	1.11^{gj}	30^{gl}	0.26^{cj}	2.09^{gj}	1.29^{ck}
B7	9^{fk}	11.29^{bh}	4.63^{di}	0.98^{hk}	22^{lq}	27.55^{af}	2.55^{bh}	1.31^{cj}
B8	11.33^{cf}	10.63^{ei}	5.47^{ad}	1.83^{be}	25^{kp}	26.44^{bi}	2.26^{fj}	1.52^{bj}
B9	6.67^{kl}	10.58^{ej}	4.76^{bi}	0.86^{ik}	16^{qr}	25.8^{cj}	2.64^{bg}	0.95^{jk}
B10	9.67^{ej}	10.31^{fk}	4.54^{ei}	1^{hk}	25.67^{jo}	22.75^{in}	2.53^{bh}	1.37^{cj}
B11	14.33^{a}	9.06^{k}	6.02^{a}	2.01^{ac}	38.33^{cg}	20.44^{lo}	1.73^{j}	1.4^{cj}
B12	12.67^{ad}	11.18^{bh}	4.7^{ci}	1.23^{fj}	28.33^{hm}	21.76^{ko}	2.3^{ej}	1.31^{cj}
B13	9^{fk}	9.24^{jk}	4.91^{bh}	1.32^{fi}	16.67^{pr}	20.25^{mo}	2.2^{fj}	0.95^{jk}
B14	8.33^{hl}	12.17^{ad}	4.7^{ch}	0.91^{ik}	27^{in}	24.28^{ek}	2.6^{bg}	1.34^{cj}
B15	11.67^{be}	11.07^{bi}	4.9^{bh}	1.28^{fj}	34.33^{fi}	25.01^{ck}	2.23^{fj}	1.52^{bj}
B16	7.67^{il}	10.96^{ci}	4.35^{hi}	0.8^{jk}	22^{lq}	28.7^{ac}	2.94^{ad}	1.03^{hk}
B17	14.33^{a}	12.18^{ad}	4.98^{bh}	2.16^{ab}	48.67^{a}	25.3^{ck}	2.0^{gj}	2.79^{a}
B18	12.67^{ad}	11.71^{ae}	5.52^{ac}	2.01^{ac}	49^{a}	25.66^{cj}	2.04^{gj}	2.81^{a}
B19	10^{ei}	9.79^{ik}	4.47^{fi}	1^{hk}	21^{mq}	24.12^{fl}	2.18^{fj}	0.89^{jk}
B20	7.33^{jl}	9.942^{hk}	4.81^{bi}	0.89^{ik}	18^{or}	24.87^{dk}	2.9^{ae}	1.23^{dk}
B21	6.33^{l}	10.03^{hk}	4.93^{bh}	0.81^{jk}	17.67^{or}	23.87^{fm}	3.03^{ac}	1.02^{hk}
B22	12^{ae}	11.68^{af}	5.04^{bh}	1.54^{dg}	37.33^{dg}	26.92^{bg}	2.37^{dj}	2.23^{ab}
B23	12.67^{ad}	10.59^{ej}	4.69^{ci}	1.42^{eh}	39^{bf}	22.72^{in}	1.81^{ij}	1.45^{bj}
B24	8.33^{hl}	10.72^{ei}	5.62^{ab}	1.23^{fj}	19.33^{nq}	19.87^{no}	2.13^{gj}	1.05^{gk}
B25	9.67^{ej}	11.26^{bh}	4.6^{di}	0.85^{ik}	17^{pr}	24.58^{dk}	2.62^{bg}	0.97^{ik}
B26	6.67^{kl}	9.06^{k}	5.33^{af}	0.56^{ck}	11^{r}	24.57^{dk}	3.09^{ab}	0.49^{k}
B27	8.33^{hl}	10.22^{gk}	4.56^{ei}	0.97^{hk}	16^{qr}	24.13^{fl}	2.58^{bg}	0.95^{jk}
B28	12^{ae}	11.21^{bh}	4.9^{bh}	1.55^{dg}	32.67^{fk}	26.25^{bi}	2.45^{ci}	1.86^{bf}
B29	11.33^{cf}	12.32^{ac}	4.61^{di}	1.1^{gj}	50^{a}	0.28^{ae}	2.25^{fj}	2.01^{bd}
B30	12^{ae}	11.55^{bg}	4.33^{hi}	1.11^{gj}	33^{fk}	26.07^{bj}	1.9^{hj}	1.11^{fk}
B31	10.33^{dh}	12.99^{a}	4.4^{gi}	1^{hk}	43^{ae}	28.13^{ad}	2.07^{gj}	1.78^{bi}
B32	12^{ae}	10.9^{di}	4.88^{bh}	1.11^{gj}	46^{ac}	18.96^{o}	2.55^{bh}	1.85^{bg}
B33	7.67^{il}	11.2^{bh}	5.24^{ag}	0.57^{k}	21.33^{mq}	29.73^{ab}	3.38^{a}	1.06^{fk}
B34	7.33^{jl}	9.73^{ik}	3.95^{i}	0.6^{k}	20.67^{mq}	0.25^{ck}	2.58^{bg}	0.95^{jk}
B35	8.67^{gl}	10.43^{ej}	4.4^{gi}	1.23^{fj}	25^{kp}	26.26^{bi}	2.35^{dj}	1.23^{dk}
B36	11^{dg}	9.962^{hk}	4.74^{bi}	1.5^{eg}	36.33^{eh}	23.54^{gm}	2.3^{ej}	1.93^{be}
B37	10.33^{dh}	11.07^{bi}	4.6^{di}	1.15^{gj}	34^{fj}	30.49^{a}	2.12^{gj}	1.13^{ek}
B38	13.67^{ac}	9.92^{hk}	4.91^{bh}	1.65^{cf}	34.33^{fi}	23.55^{gm}	2.04^{gj}	1.83^{bh}
B39	12.67^{ad}	9.26^{jk}	4.99^{bh}	2.35^{a}	35.33^{ei}	22.35^{jo}	2.05^{gj}	2.07^{bc}
B40	14^{ab}	11.71^{ae}	5.17^{bh}	1.96^{ad}	39^{bf}	22.88^{hn}	2.41^{ci}	2.07^{ac}
Mean	10.57	10.87	4.84	1.25	30.52	24.98	2.39	1.49

In column, means followed by a common small letter are not statistically different at the 5% level by dMRT

rice recovery, kernel length, amylose content as 76.0%, 68.0%, 7.54 mm, 26.1%, respectively. As a result, in this collection of rice germplasm, one can find high potentiality for different important characters for rice improvement.

The mean separations of 40 land races of Balam rice also showed highly significant differences among the genotypes (Table 3-6). It was evident that no single duplicate genotype was found among the 40 land races of Balam rice but identical or similar genotypes were observed for individual characters. For example, the genotype B7, B8, B18, B24, B36, B37 and B40 were found statistically similar for seedling height. Similarly, the genotype B1, B8, B12, B17, B18, B23, B28 to B30, B36, B37 and B40 for plant height, the genotype B2, B8-B12, B14, B15, B17, B18, B21, B23, B26, B29, B30, B32, B33, B34, B35, B36, B37, B38 and B40 for penultimate leaf length, the genotype B11, B17, B23 and B28 for days to maturity and the genotype B1-B3, B5-B7, B10, B12-B15, B20,

Table 6: Mean performance of grain characters of 40 Balam rice

Genotypes	Grain length (mm)	LB ratio	1000-grain weight (g)	Milling out turn (%)	Headrice out turn (%)	Cooking time (min)	Elongation ratio	Imbibition ratio	Amylose content (%)	Protein content (%)
B1	8.11^{lm}	3.09^{lm}	19.59^{km}	67^{fg}	85^{h}	15^{h}	1.4^{ab}	3.4^{cd}	16^{r}	9.4^{ij}
B2	8.63^{de}	3.27^{ik}	23.56^{gi}	70.5^{cd}	49^{o}	22^{a}	1.2^{cd}	4.1^{b}	21.7^{no}	12.4^{a}
B3	8.28^{il}	4.11^{b}	14.51^{p}	67^{fg}	66^{m}	17^{fg}	1.4^{ab}	4.0^{ab}	23.1^{gj}	9.3^{jk}
B4	9.33^{c}	3.5^{fh}	23.8^{fh}	69de	92^{ef}	17^{fg}	1.4^{ab}	3.4^{cd}	23.8^{d}	5.6^{x}
B5	7.96^{m}	2.97^{mn}	21.26^{ik}	72^{ab}	76^{k}	22^{a}	1.3^{bc}	3.1^{de}	22.1^{lm}	11.8^{b}
B6	8.38^{hl}	3.18^{kl}	22.84^{gi}	65^{h}	94^{cd}	13^{i}	1.2^{cd}	3.7^{bc}	23^{hj}	9.9^{g}
B7	9.06^{d}	3.58^{ef}	24.09^{eh}	70^{cd}	82^{i}	18^{df}	1.3^{bc}	3.4^{cd}	23.5^{df}	8^{t}
B8	10.83^{a}	4.56^{a}	25.85^{de}	66^{gh}	95^{bc}	13^{i}	1.2^{cd}	3.4^{cd}	23.4^{eg}	8.1st
B9	8.5^{ej}	3.24^{jl}	22.4^{gi}	71^{bc}	96^{b}	19^{cd}	1.4^{ab}	3.4^{cd}	21.4^{o}	8.6^{p}
B10	8.5^{ej}	3.15^{kl}	22.73^{gi}	71^{bc}	94^{cd}	18^{df}	1.3^{bc}	3.4^{cd}	23.2^{fi}	9.2^{kl}
B11	7.97^{m}	2.67^{qs}	22.9^{gi}	69de	85^{h}	19^{d}	1.4^{ab}	3.7^{bc}	20.7^{p}	11.3^{c}
B12	8.73^{ef}	3.81^{cd}	19.11^{lm}	70^{cd}	93de	18^{df}	1.4^{ab}	4.0^{ab}	21.8^{mn}	9.2^{kl}
B13	8.5^{ej}	2.66^{qs}	28.84^{b}	69de	96^{b}	18^{df}	1.2^{cd}	3.4^{cd}	21.4^{o}	9^{mn}
B14	8.44^{fk}	3.47^{fi}	20.17^{jl}	73^{a}	78^{j}	20^{bc}	1.2^{cd}	3.4^{cd}	25.9^{a}	7.7^{u}
B15	8.46^{fk}	3.17^{kl}	22.12^{hi}	71^{bc}	95^{bc}	19^{cd}	1.4^{ab}	3.4^{cd}	22.7^{jk}	9.6^{h}
B16	8.71^{eg}	3.78^{cd}	18.79^{lm}	71^{bc}	99^{a}	17^{fg}	1.4^{ab}	4.0^{b}	22.17^{lm}	8.8^{o}
B17	8.41^{gl}	2.48^{tv}	29.48^{b}	70^{cd}	95^{bc}	18.33^{de}	1.3^{bc}	3.4^{cd}	23.5^{df}	8.3^{qr}
B18	8.19^{jm}	2.44^{uw}	29.1^{b}	70^{cd}	33^{q}	19^{d}	1.2^{cd}	3.7^{bc}	24.7^{b}	8.8^{o}
B19	8.64^{eh}	2.61^{rt}	23.93^{eh}	63^{i}	41^{p}	18^{df}	1.3^{bc}	4.0^{ab}	20.6^{p}	10.3^{f}
B20	7.55^{n}	2.47^{tv}	23.18^{gi}	70^{cd}	86^{h}	20.33^{b}	1.5^{a}	4.3^{a}	22.8^{ij}	7.2^{v}
B21	7.64^{n}	2.69^{ps}	19.52^{km}	69de	91^{fg}	16^{gh}	1.3^{bc}	3.1^{de}	22.83^{ij}	9^{mn}
B22	9.02^{d}	3.38^{hj}	24.17^{eh}	70^{cd}	86^{h}	18^{df}	1.3^{bc}	3.4^{cd}	23.8^{d}	9.5^{hi}
B23	8.81^{de}	3.38^{hj}	21.71^{ij}	70^{cd}	68^{l}	20^{bc}	1.3^{bc}	3.1^{de}	24.3^{c}	11.0^{d}
B24	8.4^{gl}	2.77^{or}	25.67^{df}	70^{cd}	85^{h}	19^{cd}	1.3^{bc}	3.4^{cd}	23^{hj}	10.5^{e}
B25	8.42^{fl}	2.88^{no}	26.8^{cd}	68^{ef}	90^{g}	16.93^{fg}	1.3^{bc}	4.0^{ab}	22.9^{ij}	9.1^{lm}
B26	7.92^{m}	2.53^{su}	23.13^{gi}	68^{ef}	96^{b}	16^{gh}	1.3^{bc}	3.4^{cd}	23.7^{de}	8.4^{q}
B27	8.36^{hl}	2.82^{nq}	25.57^{df}	70^{cd}	93de	17^{fg}	1.2^{cd}	3.7^{bc}	16.7^{q}	8^{t}
B28	8.7^{eg}	3.35^{hj}	23.8^{fh}	70^{cd}	83^{i}	16^{gh}	1.2^{cd}	4.0^{ab}	25.6^{a}	8^{t}
B29	8.39^{gl}	3.36^{hj}	18.83^{lm}	69.5^{ce}	67^{lm}	17.5^{ef}	1.3^{bc}	3.0^{e}	24.23^{c}	6.77^{w}
B30	8.64^{eh}	3.67^{de}	17.8^{mn}	70^{cd}	95^{bc}	18^{df}	1.4^{ab}	3.4^{cd}	22.7^{jk}	9.2^{kl}
B31	9.61^{c}	3.92^{c}	22.78^{gi}	70^{cd}	66^{m}	18^{df}	1.4^{ab}	3.4^{cd}	24.5^{bc}	10.3^{f}
B32	6.47^{o}	2.3^{w}	16.44^{no}	71^{bc}	95^{bc}	21^{ab}	1.1^{d}	4.0^{ab}	22.4^{kl}	8.3^{qr}
B33	6.43^{o}	2.33^{vw}	16.0^{op}	69de	62^{n}	15^{h}	1.4^{ab}	3.4^{cd}	21.6^{no}	8.9^{no}
B34	8.54^{ei}	3.41^{gi}	18.25^{lm}	70^{cd}	66^{m}	21^{b}	1.3^{bc}	4.0^{ab}	22.4^{kl}	8.1st
B35	8.37^{hl}	2.62^{rt}	28.29^{bc}	69de	94^{cd}	17^{fg}	1.3^{bc}	3.7^{bc}	22.1^{lm}	8.47^{pq}
B36	8.4^{gl}	2.85^{np}	24.29^{eg}	70^{cd}	85^{h}	21^{b}	1.3^{bc}	3.7^{bc}	22.9^{hj}	10.2^{f}
B37	9.49^{c}	3.55^{eg}	23.91^{eh}	69de	95^{bc}	18^{df}	1.2^{cd}	3.4^{cd}	23.3^{fh}	9.8^{g}
B38	8.28^{il}	2.75^{or}	26.38^{d}	69de	92^{ef}	16^{gh}	1.4^{ab}	3.7^{bc}	20.6^{p}	8.2^{rs}
B39	9.89^{b}	3.44^{fi}	33.22^{a}	70^{cd}	94^{cd}	17^{fg}	1.4^{ab}	3.4^{cd}	21.3^{o}	9.8^{g}
B40	8.15^{km}	2.66^{qs}	25.83^{de}	69de	93de	17^{fg}	1.1^{d}	3.4^{cd}	22.2^{l}	11.1^{d}
Mean	8.48	3.12	23.00	69.36	83.13	17.90	1.31	3.58	22.51	9.13

In column, means followed by a common small letter are not statistically different at the 5% level by DMRT

B23, B30, B31, B32, B35 and B37 for grain yield per hill were found statistically duplicate. Besides, genotype B-B6, B7, B10, B15, B19, B22, B25, B28, B30, B31, B32, B36 and B37 for primary branch number per panicle and genotype B1, B5, B11, B15, B22, B23, B28, B30, B36, B37, B38, B39 and B40 for secondary branch number per panicle found statistically identical. Similarly, genotype B1, B3, B6, B17, B18, B24, B25, B27, B29, B35, B36 and B38 for grain length, genotype B2, B7, B9, B10, B12, B15-B18, B20, B22, B23, B24, B27, B28, B30-B32, B34, B36 and B39 for milling outturn and genotype B3, B4, B7, B10, B12, B13, B16, B19, B22, B25, B27, B29-B31, B35, B37, B39 and B40 for cooking time were found statistically similar. Therefore, it was evident from the result that none of the genotype was found duplicate with others regarding the 38 morpho-physiochemical characters.

Hossain (2008) also observed highly significant differences among the aromatic and fine grain land races of rice genotypes with duplicate names for all the morphological and physico-chemical characters studied. Nascimento *et al.* (2011) by studying 146 accessions with same names of upland rice for 14 quantitative traits found significant differences. However, Fukuoka *et al.* (2006) studied aromatic rice land races and concluded that significant variation may be found among genotypes with the same name for quantitative traits. Besides, Kisandu and Mghogho (2004) studied 275 accessions from all rice growing regions of the Southern Highlands of Tanzania and reported that a large number of similar names were existed for rice cultivars. Finally, it can be said that wide ranges of variations were present in the land races as each genotype was clearly distinct from others though have similar or duplicate names.

Genetic parameters of balam rice: The genetic parameters of 40 land races of Balam rice with duplicate and similar names are presented in Table 7. It was apparent from the table that the genotypic and phenotypic coefficient of variations were found close to each other for seedling height as 11.6 and 11.9%, plant height as 15 and 15.6%, days to maturity as 7 and 7%, grain length as 8.9 and 9.2%, L/B ratio as, 16.7 and 17% and 1000-grain weight as 17 and 17.6%, respectively indicated less environmental influence and additive gene action for the characters. But wide differences were found for filled grains weight per secondary branch as 31.8 and 42.1%, followed by effective tiller number per hill as 25.4 and 34.2%, filled grains number per secondary branch as 13.4 and 18.9%, grain yield per panicle as 30.7 and 36.1%, filled grains weight per primary branch as 32.6 and 38%, respectively. Higher estimates of both GCV and PCV were found for panicle exertion (39.4 and 44.5%, respectively), followed by filled straw yield per hill (37.1 and 41.6%), filled grain weight per secondary branch (31.8 and 42.1%), biological yield (35.2 and 40%), secondary branch number (34.2 and 37.1%), grain weight per primary branch (32.6 and 38%), grain yield per panicle (30.7 and 36.1%), grain yield per hill (30.9 and 36.2%) and effective tiller number per hill (25.4 and 34.2%), indicated wide degree of variability for these traits. But very little GCV was found in filled grain number per primary branch (6.4%), followed by days to maturity (7%), panicle length (7.1%) and flag leaf length (7.7%) indicating lack of inherent variability for these traits among the test genotypes.

However, high h^2_b coupled with high GAPM were found for LB ratio (96.5 and 33.9%), followed by 1000-grain weight (93.2 and 33.8%), culm height (91.5 and 34.7%), plant height (91.8 and 29.6%), secondary branch number (85 and 65%), straw yield per hill (79.4 and 68.1%) and panicle exertion (78.3 and 71.9%), respectively suggested that they were simply inherited traits governed by a few genes with additive effects. While high h^2_b estimates with low GAPM was found for days to maturity (100 and 14.4%, respectively). Again, high GCV, heritability and GAPM were observed in culm height (17.6, 91.5 and 34.7%), 1000-grain weight (17, 93.2 and 33.8%), LB ratio (16.7, 96.5 and 33.9%), panicle exertion (39.4, 78.3 and 71.9%), secondary branch number (34.2, 85 and 65%), plant height (15, 91.8 and 29.6%), biological yield (35.2, 77.3 and 63.7%), straw yield per hill (37.1, 79.4 and 68.1%), seedling height (11.6, 95.3 and 23.3%), penultimate leaf width (11.7, 81.7 and 21.8%) and flag leaf width (10.6, 81.3 and 19.6%), respectively.

Ghosal *et al.* (2010) by studied 18 advanced breeding lines for yield contributing characters during Boro season, observed the genotypic and phenotypic coefficient of variations close to each other for plant height, panicle length, 1000-grain weight, growth duration and yield, while some differences were found for effective tillers per sq. meter and spikelet sterility indicating influence of environment on the expression of these characters. Thus, improvement of studied germplasm may be possible through direct selection for the characters having high GCV and PCV in segregating generations.

Iftekharuddaula *et al.* (2001) studied 24 modern rice varieties of irrigated ecosystem found high heritability coupled with high genetic advance in percent of mean in plant height, 1000-grain weight, spikelet per panicle and grain yield per panicle. Ghosal *et al.* (2010) documented high h^2_b

Table 7: Genetic parameters of 38 morpho-physicochemical characters of 40 Balam rice

Characters	GCV (%)	PCV (%)	H^2_b (%)	GA	GAPM (%)
Coleoptile length (mm)	12.7	15.0	71.8	2.4	22.2
Seedling height (cm)	11.6	11.9	95.3	14.4	23.3
Penultimate leaf length (cm)	8.4	10.6	62.9	7.0	13.8
Penultimate leaf width (mm)	11.7	13.0	81.7	2.5	21.8
Penultimate leaf area (cm^2)	15.9	18.2	76.7	12.6	28.7
Flag leaf length (cm)	7.7	12.2	40.3	3.7	10.1
Flag leaf width (mm)	10.6	11.7	81.3	2.8	19.6
Flag leaf area (cm^2)	10.3	15.2	45.8	5.5	14.3
Culm height (cm)	17.6	18.4	91.5	35.0	34.7
Culm diameter (mm)	14.0	15.2	85.1	1.4	26.6
Plant height (cm)	15.0	15.6	91.8	37.1	29.6
Panicle exertion (cm)	39.4	44.5	78.3	2.7	71.9
Effective tiller number per hill	25.4	34.2	55.0	5.9	38.7
Straw yield per hill (g)	37.1	41.6	79.4	19.1	68.1
Days to maturity	7.0	7.0	100.0	20.4	14.4
Panicle length (cm)	7.1	7.9	79.3	3.2	13.0
Grain yield per panicle (g)	30.7	36.1	72.4	1.5	53.9
Grain yield per hill (g)	30.9	36.2	72.8	12.1	54.3
Harvest index (HI)(%)	14.5	18.8	59.1	9.4	22.9
Biological yield (BY) (g)	35.2	40.0	77.3	30.3	63.7
Primary branch number	20.5	23.9	73.1	3.8	36.1
Av. primary branch length (cm)	8.5	10.6	64.3	1.5	14.0
Filled grain number per primary branch	6.4	11.1	33.7	0.4	7.7
Primary branch filled grain weight (g)	32.6	38.0	73.5	0.7	57.6
Secondary branch number	34.2	37.1	85.0	19.8	65.0
Av. secondary branch length (mm)	9.9	12.5	62.8	4.0	16.2
Filled grain number per secondary branch	13.4	18.9	50.8	0.5	19.7
Secondary branch filled grain weight (g)	31.8	42.1	56.8	0.7	49.3
Grain length (mm)	8.9	9.2	95.0	1.5	17.9
LB ratio	16.7	17.0	96.5	1.1	33.9
1000-grain weight (g)	17.0	17.6	93.2	7.8	33.8
Milling outturn (%)	2.5	2.8	76.0	3.1	4.4
Head rice outturn (%)	19.3	19.3	99.8	33.1	39.8
Cooking time (min)	11.5	11.9	93.2	4.1	22.9
Elongation ratio	6.3	9.9	40.0	0.1	8.2
Imbibition ratio	8.4	9.7	75.0	0.5	15.0
Amylose content (%)	8.4	8.4	98.6	3.9	17.1
Protein content (%)	14.8	14.8	99.5	2.8	30.4

GCV: Genotypic coefficient of variation, PCV: Phenotypic coefficient of variation, H^2_b: Heritability, GA: Genetic advance, GAPM: Genetic advance in percent of mean

estimate with high GAPM for yield, 1000-grain weight, panicle length, spikelet sterility and plant height suggested that they were simply inherited traits governed by a few major genes or additive gene effects. Besides, Shanthakumar *et al.* (1998) found high genotypic coefficient of variability together with high heritability and genetic advance for plant height, total tillers per hill, flag leaf length panicle length, spikelet fertility, 1000-grain weight and grain yield. However, Prasad *et al.* (2001) studied eight fine rice genotypes and found that 1000-grain weight, number of effective tiller per plant, number of fertile grain per panicle and yield per plant showed high GCV and high heritability coupled with high GAPM. Therefore, selection may be effective for these characters in segregating generations.

Correlation coefficients between different characters of balam rice: Out of 73 very highly significant ($p<0.001$) estimates among the total 153 correlations obtained between 18 different character pairs, 63 correlation coefficients were positive in nature and only 10 estimates were negative (Table 8). This represents very highly favorable situation for obtaining high response to selection in improving yield and yield components in rice germplasm evaluated. The measure of degree of symmetrical association between two variables or characters revealed that SBFGW had

Table 8: Estimates of simple correlation coefficients between 18 agro-morphological characters of 40 Balam rice

Correlation parameters	PFLA	PH	ENT	DM	PL	PBN	APBL	PFGN	PFGW	SBN	ASBL	SFGN	SFGW	GL	LBR	TGW	PGY
PFLA	1																
PH	0.496***	1															
ENT	-0.399***	0.181*	1														
DM	0.405***	0.822***	0.209*	1													
PL	0.364***	0.562***	0.190*	0.513***	1												
PBN	0.421***	0.753***	0.169	0.733***	0.642***	1											
APBL	0.054	0.066	0.146	0.118	0.562***	0.197*	1										
PFGN	0.188*	0.268**	-0.165	0.142	0.065	0.104	-0.041	1									
PFGW	0.460***	0.689***	-0.029	0.607***	0.488***	0.679***	0.048	0.464***	1								
SBN	0.432***	0.604***	0.075	0.646***	0.656***	0.728***	0.480***	0.020	0.518***	1							
ASBL	-0.003	-0.051	0.003	-0.065	0.221*	-0.133	0.416***	-0.150	-0.252**	0.053	1						
SFGN	-0.269**	-0.435***	-0.107	-0.435***	-0.336***	-0.415***	-0.064	-0.077	-0.475***	-0.334***	0.320***	1					
SFGW	0.419***	0.495***	0.024	0.526***	0.587***	0.589***	0.423***	0.130	0.609***	0.791***	0.074	-0.048	1				
GL	0.081	0.222*	0.138	0.276**	0.371***	0.157	0.113	-0.106	0.316***	0.060	0.189*	-0.346***	0.109	1			
LBR	-0.085	0.153	0.292***	0.275**	0.346***	0.128	0.259**	-0.212*	0.002	0.132	0.316***	-0.078	0.044	0.741***	1		
TGW	0.266**	0.183*	-0.136	0.110	0.096	0.145	-0.159	0.154	0.540***	-0.042	-0.161	-0.342***	0.206*	0.411***	-0.227**	1	
PGY	0.486***	0.645***	0.001	0.625***	0.607***	0.699***	0.292***	0.304***	0.864***	0.750***	-0.073	-0.259**	0.925***	0.221*	0.030	0.389***	1
HGY	0.224**	0.662***	0.364***	0.685***	0.611***	0.667***	0.161	0.048	0.611***	0.562***	-0.069	-0.368***	0.557***	0.335***	0.231**	0.263**	0.646***

PFLA: Penultimate and flag leaf area, PH: Plant height, ENT: Effective tiller number per hill, DM: Days to Maturity, PL: Panicle length, PBN: Primary branch number, APBL: Average primary branch length, PFGN: Filled grain number per primary branch, PFGW: Primary branch filled grain weight, SBN: Secondary branch number, ASBL: Average secondary branch length, SFGN: Filled grain number per secondary branch, SFGW: Secondary branch filled grain weight, GL: Grain length, LBR: LB ratio, TGW: 1000-grain weight, PGY: Grain yield per panicle, HGY: Grain yield per hill, ***,**,*Significant at 0.1, 1 and 5% probability levels, respectively the highest very highly significant positive (0.925) association with PGY, followed by PBFGW (0.864) with PGY, PH (0.822) with DM, SBFGW (0.791) with SBN, PBN (0.753) with PH, SBN (0.750) with PGY, LBR (0.741) with GL, PBN (0.733) with DM, SBN (0.728) with PBN etc. Besides, the SBFGN had the highest very highly significant negative (-0.475) association with PBFGW, followed by SBFGN (-0.435) with PH, SBFGN (-0.435) with DM, SBFGN (-0.415) with PBN etc. Therefore, these characters emerged as most important associates of grain yield in rice.

Secondly, among the 12 highly significant ($p<0.01$) estimates, 8 correlation estimates were positive in nature and 4 were negative. The GL showed the highest highly significant positive (0.276) association with DM, followed by LBR (0.275) with DM, PBFGN (0.268) with PH, TGW (0.266) with PFLA etc. Besides, the SBFGN showed the highest highly significant negative (-0.269) association with PFLA, followed by SBFGN (-0.259) with PGY, ASBL (-0.252) with PBFGW etc. Therefore, these characters emerged as important associates of grain yield in rice. Finally among the 12 significant ($p<0.05$) estimates, 11 correlation estimates were positive in nature and one were negative. The GL showed the highest significant positive (0.222) association with PH, followed by ASBL (0.221) with PL, GL (0.221) with PGY, ENT (0.209) with DM etc. Besides, only PBFGN showed the highest significant negative (-0.212) association with LBR. The above observations of strong positive associations between yield and yield components are in agreement with the available literature in rice (Chaudhary and Motiramani, 2003; Zahid *et al.*, 2006; Yadav *et al.*, 2011). Results indicated that greater the PBN, PBFGW, SBN, SBFGW and LB ratio possessed higher the GL and PGY, which appears logical.

CONCLUSIONS

The traditional rice germplasm can offer a valuable gene pool. Highly significant differences among the land races were observed. The highest potentiality (positive) were found in B39 for straw yield per hill, biological yield and 1000-grain weight, B11 for culm height and plant height, B17 for primary branch number, grain yield per panicle and grain yield per hill, B8 for grain length and B2 for protein content and the lowest potentiality (negative) were found in B32 for 1000-grain weight and B31 for plant height, respectively. Finally, molecular characterizations of identified genotypes need to be done for QTL mapping of valuable traits.

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