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BRRI dhan80: High Yielding Jasmine Type Aromatic Rice Variety for Wet Season of Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAK planned the experiment and lead the research. Authors MAK and TLA designed and carried out the research. Authors RRM and TKH performed the statistical analysis. Authors RRM and TKH carried out the research on the field. Authors RRM and MEH collected the data. Authors RRM and MEH wrote the manuscript. Authors TLA and RRM managed the literature searches. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A newly released jasmine type, aromatic, high yielding, long slender grain and exportable rice variety *viz*., BRRI dhan80, suitable for rain-fed low land ecosystem of Bangladesh is advancement over existing premium quality rice varieties. The variety has reasonably conceded the Proposed Variety Trial (PVT) conducted at the farmer's field. As a result National Seed Board (NSB) of Bangladesh has sanctioned this variety for its commercial cultivation in the wet season (Transplanted Aman season) in 2017. It has modern plant type with 120 cm plant height and matures by 130-135 days. The salient feature of this variety is like jasmine as having good quality grain, aroma, ten days earlier maturing than check variety. The proposed variety exposed around 1.0 t/ha higher yield than check variety namely BRRI dhan37. Isolating characters of this variety are deep blackish green leaf, erect to semi erect flag leaf, long slender aromatic grain with colored tip and presence of anthocyanin pigmentation/coloration on stem nodes. Its grain yield producing

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range is 4.5-5.0 t/ha grain yield. It has long and erect flag leaf with deep green color, brownish root and strong stem. Thousand grain weight of the variety is 26.2 gm and it has colored grain tip and pointed awn. This variety has 23.6% amylose content and 8.5% protein content. The jasmine type, exportable, aromatic rice variety (BRRI dhan80) is a superb variety for cultivating in the wet season and therefore, farmers can be economically more benefited if they will prefer BRRI dhan80 for its cultivation at large scale.

Keywords: Aromatic; exportable; jasmine type; long slender; rice; wet season.

1. INTRODUCTION

Aromatic rice (*Oryza sativa* L.) genotypes are identified for its unique fragrance when processed and cooked. This is an amazing group of rice, which is considered best in quality and cooked in special occasion [1]. Aromatic rice varieties enticement higher price in market than the other non-aromatic rice varieties. Cultivation of slender, long slender as well as aromatic rice has been attaining popularity in Bangladesh over the current years, because of its huge demand both for export and national consumption [1]. Although the mostly favourable agro-climatic conditions are needed for better output. Aromatic rice is cultivated in less than 2% of the countrywide rice acreage of Bangladesh [2]. It was premeditated that, more than 04 thousand landraces of rice are espoused in different parts of Bangladesh. Only some of these are unique for quality traits including fineness, aroma, taste and protein contents [3].

In general most of the premium quality rice cultivars are low yielding [4], there are few locally adapted premium quality rice varieties namely Chiniatop, Kalizira and Kataribhog are available. Bangladesh Rice Research Institute (BRRI) released few premium quality modern rice varieties like BR5, BR34, BRRI dhan37, BRRI dhan38, BRRI dhan50 and BRRI dhan70. These varieties are also exportable after satiating local demand. It was predictable that aromatic rice varieties have engaged about 12.5% of the total transplant aman rice cultivation area [5]. Aromatic rice production in Bangladesh is getting to be common because of its high costs and export prospect [6]. Right now, it is favored by more customers regardless of their price. In the commercial perspective, farmers' total income was increased by 23% with the adoption of modern high yielding rice varieties [7]. Data on morpho-physiological characters play a decisive role in rice breeding. It is vital to know the physiological performance and genetic expression of the selective modern and aromatic rice cultivars for definite breeding ideas to improve those cultivars. Distinguishing promising morpho-physiological characteristics related with quality and yield plays a critical role in varietal expansion programs. The quality in rice is viewed as dependent on treating or milling quality, grain size and shape, appearance, fragrance and other cooking attributes [1,8].

A large portion of the consumers incline toward fine rice varieties with great cooking quality that have aroma. Because of distinct flavor and taste, aromatic rice is profoundly required by customers. This nature of rice gets a top notch cost in the market and has export prospects [9]. A fragrant rice variety may develop and yield palatably in a wide region yet its quality attributes are linked in its local region of improvement [10]. Bangladesh delivers a few fine aromatic rice varieties with superb eating quality for ordinary utilization as steamed rice and also for polao, biriani, jarda, firni type arrangements which are served on special events. Baqui et al. [11] revealed that among the aromatic rice cultivars, Chinigura was the dominating one that secured over 70% homesteads in the northern areas of Naogaon and Dinajpur. In these areas, 30% of the rice lands were secured by aromatic rice cultivars. Islam et al. [12] observed that the yield of aromatic rice was low (1.5 to 2.0 t ha-1) however, its high cost and minimal effort of development produced higher overall revenues analogized with other rice cultivars. There are nearly 3,000-5,000 local cultivars under cultivation in Bangladesh [1,13].

Selection of desirable variety of rice crops is most vital constituents for expanding rice production. Yield of rice changes because of the growing condition, for example, different locations, seasonal fluctuations, and individual dates of planting and so forth [14]. Development of rice cultivars with a high yielding ability is one of the most fundamental approaches for dealing with the predictable upsurge in the world demand [15]. There is a lot of research information on specific rice variety, but a little is familiar on comparative study of morpho-physiological

characters of rice cultivars during aman (wet) season in Bangladesh. This research work gives an account of growth and yield performance of a new high yielding aromatic fine rice variety and designates the relationship between grain yield and trial locations as well as morpho-physiological characters of the variety. This study describes the breeding procedures, parental lineage, agro-morphological characters and grain quality of BRRI dhan80.

2. MATERIALS AND METHODS

BRRI dhan80 was developed from a single cross derived from IR65610-105-2-5-2-2 (premium quality with yield potentiality) and IR67423-208-6-2-3-3 (premium quality with aroma) in the year 2003 with aim to develop an aromatic and premium quality rice variety in BRRI Gazipur. The pedigree of BRRI dhan80 is BR7697-15-4-4-2-2. The F_1 plants were grown in 2004 in the net house along with respective parents. The cross was confirmed and registered as BR7697. The next year disease and insect free, lodging resistant belonging to long slender grain along with strong plants were selected from 675 progenies in F_2 population. Pedigree selection method was followed for handling of the segregating generations within and among the rows in F_3-F_5 generations. Some homozygous progeny lines with desirable characteristics were isolated in F_6 generations. During the period of generation advance, progeny rows were selected which were resistant against diseases and insects under natural field condition. In 2010, several tolerant homozygous lines were tested in Observational Trial (OT) against BRRI dhan37 to observe homogeneity in heading, tolerance to lodging, resistance to diseases and insects as well as overall phenotypic acceptance at field condition. In 2011, the sister lines of the advanced breeding materials were tested for Preliminary Yield Trial (PYT) for primary yield evaluation. Then after proper selection in 2012, promising sister lines were tested in Secondary Yield Trial (SYT) for confirmation of the yield of the materials in the Gazipur research farm. Out of all lines, 1 promising line was subjected to Regional Yield Trial (RYT) to evaluate specific and general adaptability with standard check BRRI dhan37 in on-station condition of five regional station of BRRI in randomized complete

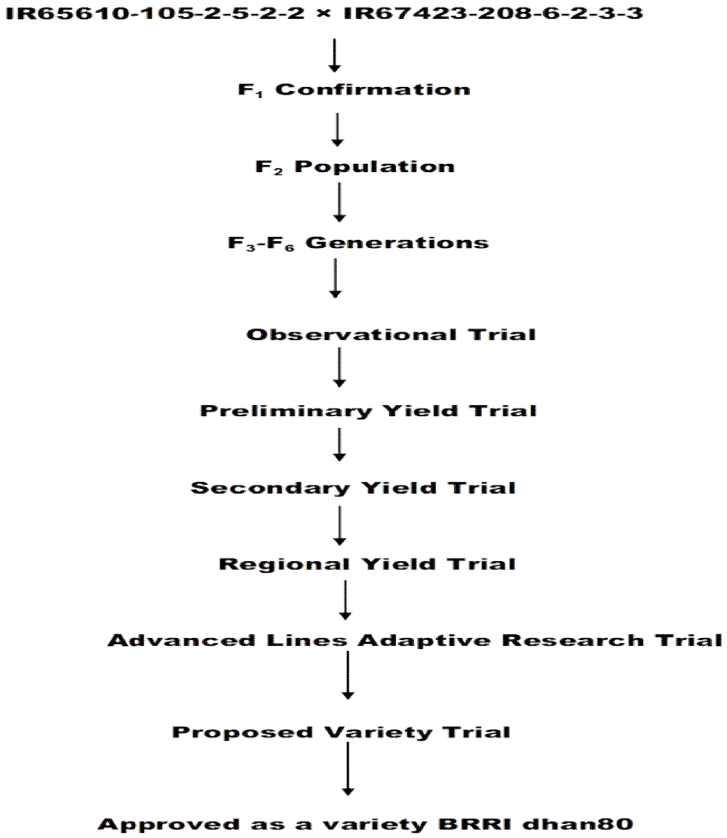

Fig. 1. Schematic diagram for development of BRRI dhan80

block (RCB) design with three replications in T. Aman 2013. After proper yield evaluation one best material/line (BR7697-15-4-4-2-2) was subjected to Advanced Lines Adaptive Research Trial (ALART) to evaluate specific and general adaptability with standard check BRRI dhan37 in the farmers' field condition in T. Aman 2014, conducted by Adaptive Research Division (ARD) of BRRI. Genotypes of the trial were tested for different physico-chemical properties, cooking qualities, best planting time, disease-insect resistance in natural condition, plant height, tillering ability were recorded from the ten random plants excluding border rows and plans surrounded by any missing hills. Growth duration was counted from seedling to 80% grain maturity. Grain yield data was taken from 10 sq-m sample plot in each replication. In T. Aman 2015, BR7697-15-4-4-2-2 (BRRI dhan80) was evaluated by the National Seed Board of Bangladesh (NSB) at ten different locations of farmers' field of Bangladesh in Proposed Variety Trial (PVT). Finally after proper evaluation the NSB team found BR7697-15-4-4-2-2 as a superior genotype in respect to grain yield, lodging tolerance, earlier than BRRI dhan37, aromatic and long slender type grain and has been released as BRRI dhan80 in the year 2017 with the approval of National Seed Board of Bangladesh (NSB) [1].

The data analyses of the experiments were done with software namely STAR, PBTools and Microsoft excel 2013 [16,17]. A schematic diagram has been illustrated about BRRI dhan80 development (Fig. 1).

3. RESULTS AND DISCUSSION

3.1 Regional Yield Trial (RYT)

The agro-morphological characteristics of BRRI dhan80 is shown in Table 1. It has moderate plant height with BRRI dhan37 which directs lodging tolerance. BRRI dhan80 has erect, long, blackish green flag leaf which facilitates maximum solar light uptake. The regional yield trial of this line was accompanied in five BRRI Regional stations of Bangladesh. BR7697-15-4-4-2-2 showed the maximum yield (4.78 t/ha), followed by BRRI dhan37 (Table 1) at Kushtia. High yield is the prime objective in mounting modern rice varieties. BRRI dhan80 showed higher yield than the check variety in T. Aman 2013. This higher yield of BRRI dhan80 was due to its genetic potentiality of producing higher and longer grains per panicle than BRRI dhan37. Average growth duration of BRRI dhan80 was found eight days earlier than BRRI dhan37. In Radar graph, the highest yield was found in Kustia with 4.78 t/ha followed by 4.30 t/ha in Cumilla and 3.28 t/ha in Rangpur. The grain yield of BRRI dhan80 is about 0.80 t/ha higher than BRRI dhan37 (Fig. 2).

3.2 Adaptive Line Research Trial (ALART)

BR7357-11-2-4-1-1(BRRI dhan80), one advanced line and check variety BRRI dhan37 were assessed at 09 different locations in the farmers' field of Bangladesh. Results are showed in the Table 2 and Fig. 3. The significant distinction was found for grain yield of the genotypes. Highest grain yield potentiality 5.40 t/ha was found for BR7697-15-4-4-2-2 in Kushtia Sadar and 5.27 t/ha was found in Jashore. The result visualizes the higher yield potentiality of BRRI dhan80 over the check genotype. On an average BRRI dhan80 yielded 1.04 t/ha higher than BRRI dhan37. Both the genotypes were almost disease free in most of the locations. The strong plant stature (121 cm) of the variety made it lodging tolerant. Growth duration was found 17 days earlier than the check variety BRRI dhan37. Farmers preferred BR7697-15-4-4-2-2 for their better yield, shorter growth duration and importantly lodging tolerance as well as long slender aromatic grain quality.

3.3 Proposed Variety Trial (PVT)

Performance of the BR7697-15-4-4-2-2 (BRRI dhan80) at on farm trial, T. Aman, 2015 is shown in Table 3. Evaluation of the BR7697-15-4-4-2-2 (BRRI dhan80) at on farm trial was executed by the National Seed Board (NSB) of Bangladesh in T. Aman 2015 season. The highest yield of the genotype was found with 5.30 t/ha in Habiganj followed by in Rangpur with 4.90 t/ha, 4.87 t/ha in Kushtia. The grain yield specified that the variety could be produce more with proper crop supervision. The grain yield range of BRRI dhan37 (Ck) was found from 2.08 - 4.75 t/ha. On an average BRRI dhan80 produced 4.46 t/ha yield whereas BRRI dhan37 produced 3.50 t/ha yield, that is 0.96 t/ha higher for the variety (Fig. 4). Growth duration of BRRI dhan80 was ranged from 155 days in Sonagazi to 123 days in Satkhira depending on the agro climatic situation in the T. Aman season. Mean growth duration of the variety was found 133 days which is fourteen days earlier than the check variety BRRI dhan37 (Table 3).

Table 1. Morphological and agronomic characteristics of BRRI dhan80, on-station Regional Yield Trial during T. Aman 2013

Designation	Plant height (cm)	Locations									
		Gazipur		Cumilla		Kushtia		Rangpur		Mean	
		GD	GY	GD	GY	GD	GY	GD	GY	GD	GY
BR7697-15-4-4-2-2	119	136	2.93	130	4.3	135	4.78	129	3.28	134	4.0
BRRI dhan37 (Ck.)	128	143	2.66	145	3.5	137	3.49	159	1.42	142	3.2
LSD (0.05)	4.00	5.20	ns	6.23	0.49	ns	0.41	3.50	1.15	5.23	0.43
Heritability	0.85	0.89	0.86	0.81	0.89	0.84	0.91	0.88	0.79	0.82	0.86

GD: Growth Duration, GY: Grain Yield

Table 2. Performance of the BR7697-15-4-4-2-2 (BRRI dhan80) at different zonal trial in farmers' field during T. Aman 2013

SN	Designation	PH	GD	Grain yield (t/ha)										
				Chittagonj Hathazari	Kushtia Sadar	Jashore Jhikorgacha	Satkhira Sadar	Rajshahi Godagari	Kishorgonj Pakundia	Sylhet Sadar	Barisal Sadar	Gazipur BRRI	Comilla Muradnagar	Mean
1	BR7697-15-4-4-2-2 (BRRI dhan80)	121	131	4.33	5.40	5.27	4.60	4.50	5.10	4.67	4.90	3.60	3.90	4.63
2	BRRI dhan37 (Ck.)	130	148	4.00	4.60	3.74	2.90	3.31	3.68	4.48	3.50	3.00	2.66	3.59
LSD (0.05)		4.55	0.43	0.47										0.15

PH: Plant height, GD: Growth Duration

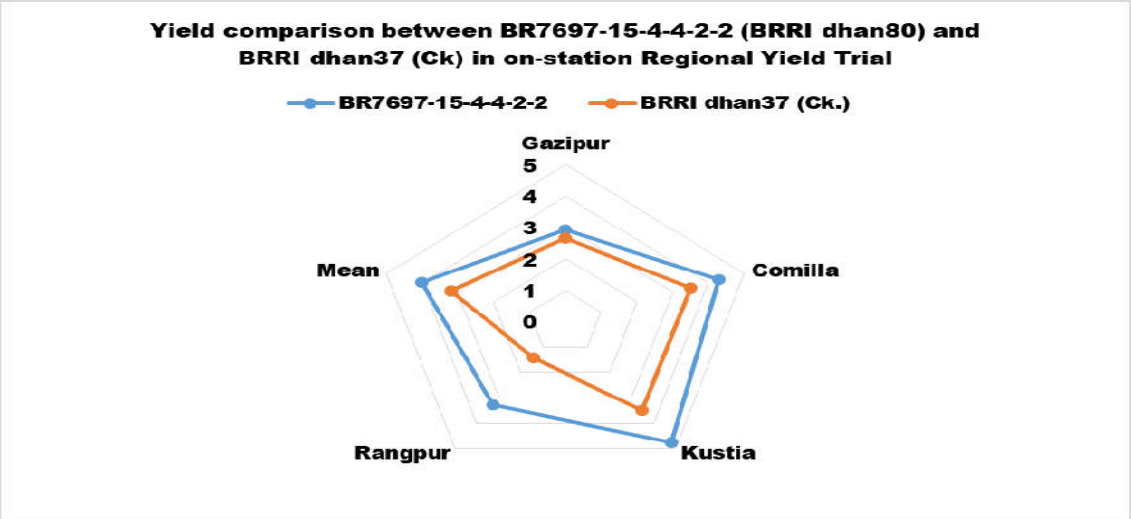

Fig. 2. Location-wise grain yield comparison between BR7697-15-4-4-2-2 (BRRI dhan80) and BRRI dhan37 (Ck)

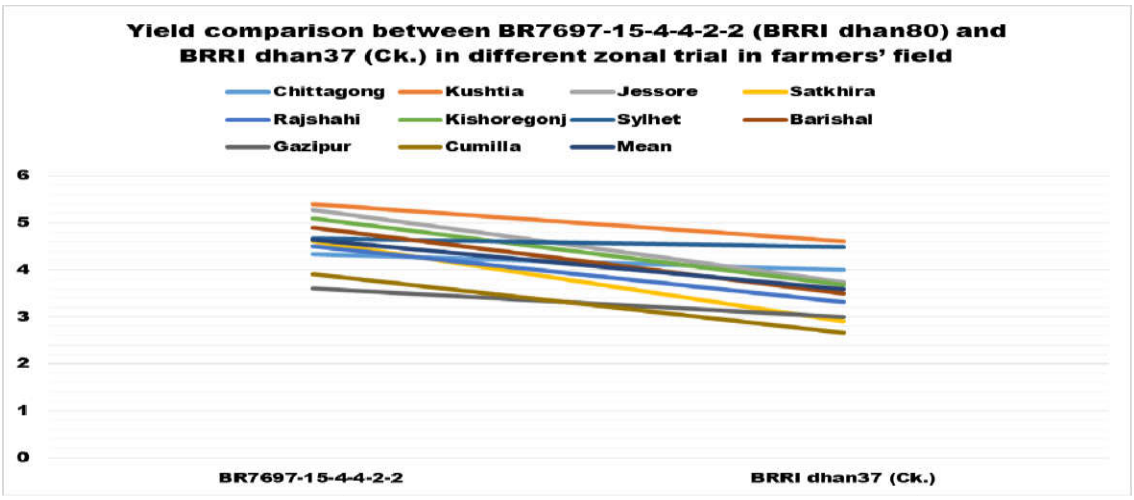

Fig. 3. Yield performances of proposed line BR7697-15-4-4-2-2 (BRRI dhan80) in eight locations of Bangladesh

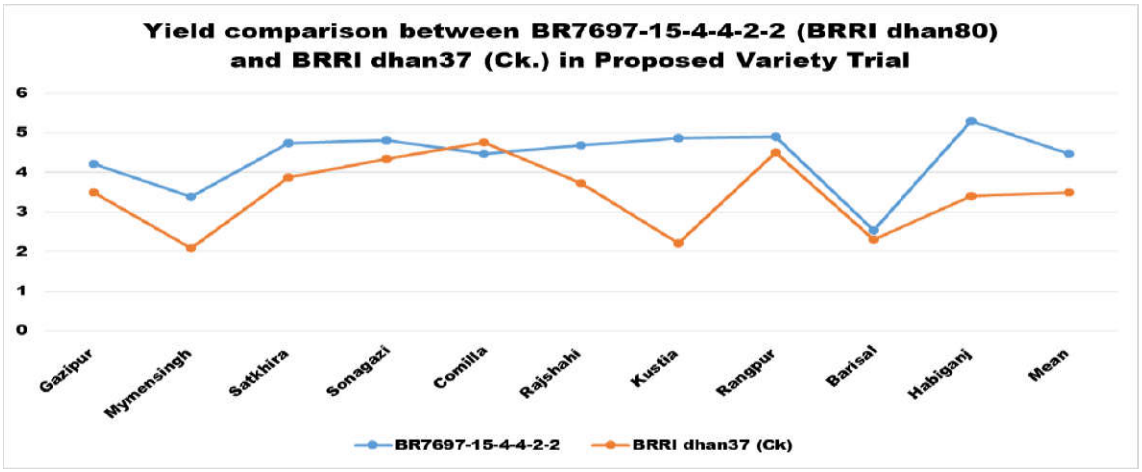

Fig. 4. Yield performances of proposed line in ten locations of Bangladesh

Table 3. Performance of the BR7697-15-4-4-2-2 (BRRI dhan80) at proposed variety trial (PVT) in farmers' field during T. Aman, 2015

Location	BR7697-15-4-4-2-2		BRRI dhan37 (Ck)	
	Growth duration (days)	Grain yield (t/ha)	Growth duration (days)	Grain Yield (t/ha)
Gazipur	127	4.21	152	3.50
Mymensingh	131	3.38	153	2.08
Satkhira	123	4.74	144	3.87
Sonagazi *	155	4.82	155	4.35
Comilla *	143	4.47	157	4.75
Rajshahi	130	4.69	145	3.73
Kustia	125	4.87	149	2.22
Rangpur *	143	4.90	147	4.50
Barisal *	140	2.54	150	2.31
Habiganj	135	5.30	143	3.40
Mean	133	4.46	149	3.50

** Water logged condition*

Additive Main effects and Multiplicative Interaction (AMMI) model shows only environmental interaction for predicted potentiality of breeding line. According to AMMI Biplot, the BRRI dhan80 is the best performer in Mymensingh (E2) followed by in Rajshahi (E6). It will perform constantly in Satkhira (E3). BRRI dhan80 will comparatively less perform in Cumilla (E5) (Fig. 5).

The What-won-where Biplot analysis indicates BRRI dhan80 (G1) was higher yielder than BRRI dhan37 (G2) among trial locations except one location (E5) (Fig. 6).

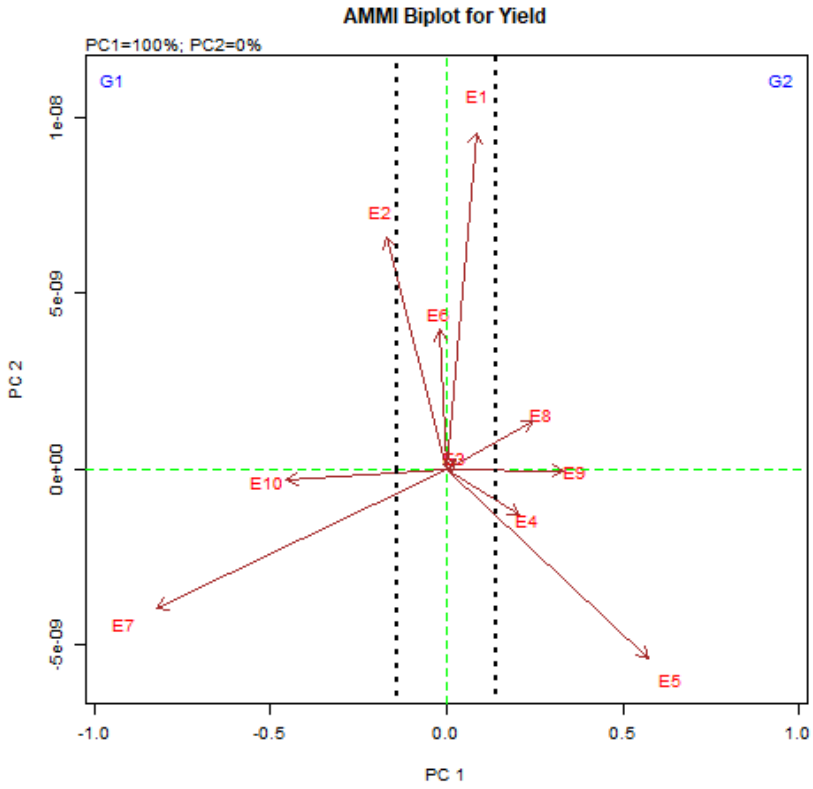

Fig. 5. AMMI Biplot analysis showing the environmental interaction to genotypes

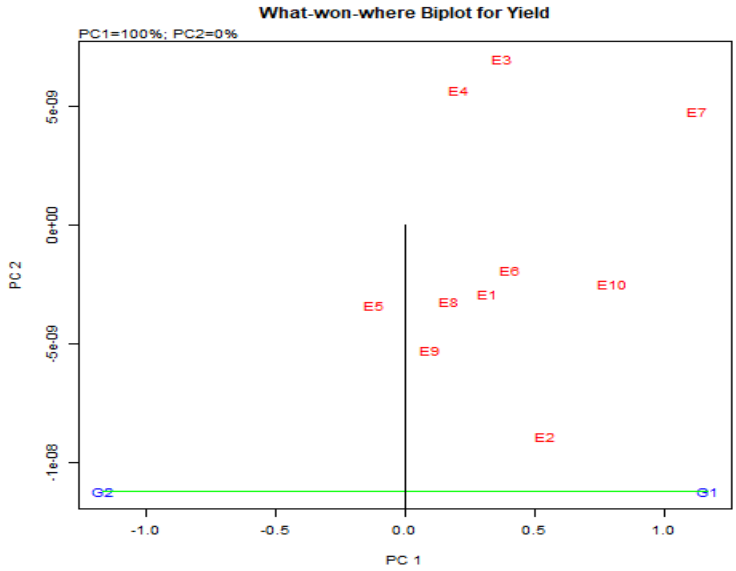

Fig. 6. What-won-where Biplot analysis shows the better performance of BRRI dhan80 in each trial location

An Adaptation Map was constructed using data from ten farmer's field trial, the analysis predicts that BRRI dhan80 is likely to be more adapted variety than the BRRI dhan37 in nine out of ten trial locations (Fig. 7).

3.4 Disease and Insect Reaction

BRRI dhan80 showed tolerance to major diseases and insects under the natural field condition in the field of Plant breeding division. The variety showed a bacterial score 1, meaning it is tolerant to bacterial blight [18]. The variety is found resistant to sheath blight disease and Blast (Table 4). For the insects the variety is also tolerant to brown plant hopper for the dead heart and white head symptoms. BRRI dhan37 also more or less showed similar symptoms.

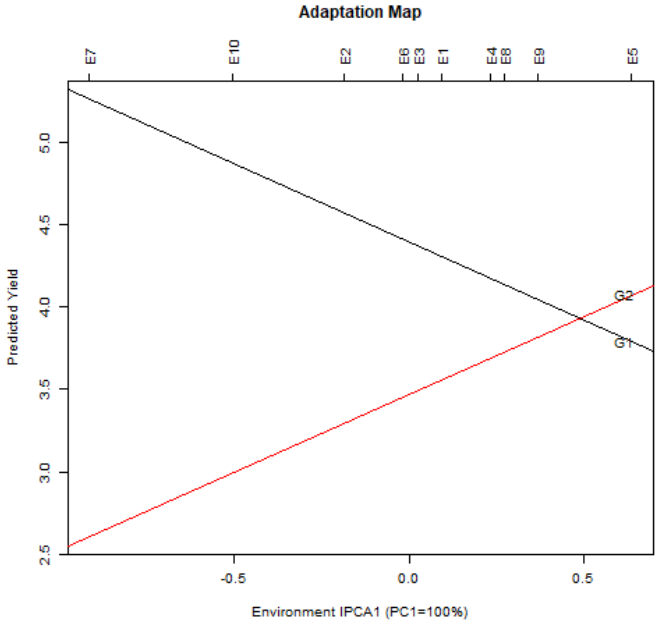

Fig. 7. Adaptation map of BRRI dhan80

Table 4. Reaction of the BRRI dhan80 against major diseases and insects under natural field condition during T. Aman 2013

Designation	BB	ShB	Blast	DH	WH
BR7697-15-4-4-2-2	1	1	0	1	1
BRRI dhan37 (Ck.)	1	3	0	1	1

BB = Bacterial Blight, ShB = Sheath Blight, DH = Dead Heart, WH = White Head
Disease and Insect severity scale (0 – 9)

3.5 Distinctive Characters

BRRI dhan80 is a long slender grain having length is 6.9 mm and breadth is 2.1 mm however the length of BRRI dhan37 is 5.0 mm and breadth is 1.5 mm. The milling outturn of the variety is 71% with the head rice recovery 65% which is nearly to the check variety (Table 5). BRRI dhan80 is straight and it could be milled in any kind of milling machine. This result exposed that BRRI dhan80 will get high market price because of aromatic, long slender and jasmine type grain like popular rice variety of Thailand, premium quality brand polish rice. The protein and amylose percentage of BRRI dhan80 is 8.5% and 23.6% respectively (Table 5). The important feature is the higher elongation ability of the cooked rice of BRRI dhan80 than BRRI dhan37. The physicochemical property of BRRI dhan80 is presented in Table 5 represents the fine quality rice nature of BRRI dhan80. So Bangladesh could earn foreign currency by exporting the rice of BRRI dhan80.

The characters like dark green leaf, erect flag leaf, anthocyanin colored stem, grain with colored tip having pointed awn is distinctly different from the check variety BRRI dhan37. At 50% heading date time only 0.5% off-type was observed for both the lines. It indicated that the candidate variety BR7697-15-4-4-2-2 is uniform according to UPOV standard. In the test plots of two consecutive seasons trials, no remarkable variation and segregation were noted which imply the stability of the candidate varieties. After proper evaluation by the National Seed Board of Bangladesh (NSB) in the ten locations of farmers' field of Bangladesh, BR7697-15-4-4-2-2 has been released as BRRI dhan80 in the year 2017. The pictorial view of BRRI dhan80 in the field condition with its grain, rice and cooked rice is shown in Figs. 8 and 9.

Fig. 8. Pictorial view of BRRI dhan80 (BR7697-15-4-4-2-2) in the field condition

Table 5. Physicochemical properties of BRRI dhan80

Designation	Milling Yield (%)	Head rice yield (%)	Decorticated grain				1000 grain wt. (g)	ER	IR	Protein (%)	Amylose (%)
			Length (mm)	Breadth (mm)	L-B Ratio	Size and shape					
BR7697-15-4-4-2-2 (Proposed Variety)	71	65	6.9	2.1	3.3	LS	26.2	1.3	3.1	8.5	23.6
BRRI dhan37(Ck.)	73	67	5.0	1.5	3.3	MS	15.5	1.2	3.7	10.3	23.8

ER= Elongation Ratio, IR= Imbibition Ratio, LS= Long slender, MS= Medium slender

BRRI dhan80 BRRI dhan37

Fig. 9. Pictorial view of rough rice, unparboiled rice and cooked rice of BRRI dhan80 and BRRI dhan37

4. CONCLUSION

In conclusion, BRRI dhan80 was released as a high yielding, aromatic, long slender and premium quality rice variety which is very parallel to a popular variety of Thailand namely Jasmine. Adaptability tests of this variety under multi-location trials in the farmers' field showed satisfactory enactment with respect to grain yield, slenderness and some yield contributing parameters. It is anticipated that this exportable aromatic rice variety will contribute to the national revenue and also alleviate poverty from Bangladesh by earning overseas currency. Farmers can cultivate robi crops (crops of winter season) timely after harvesting the crops of this variety and thus it will also increase total productivity as well.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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