

Development of High Yielding Aromatic Rice Variety BRRI dhan70 for Wet Season of Bangladesh

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Abstract: BRRI dhan70 is a new aromatic, high yielding and extra-long slender grain containing transplanted Aman rice variety which is an improvement over existing premium quality rice BRRI dhan37. BRRI dhan70 has pleasingly passed in the proposed variety trial conducted in the farmers' field. As a result National Seed Board (NSB) approved this variety for commercial cultivation in the wet season (T. Aman) of Bangladesh in 2015. The important feature of BRRI dhan70 is the straw colored extra-long slender, higher elongation ability and aroma of the cooked rice. The growth duration of BRRI dhan70 is 130 days which is 10-15 days earlier growth duration than BRRI dhan37. Thousand grain weight of the variety is 20 gm and it has colored grain tip and pointed awn. The rice has 21.7% amylose content with 9.5% protein content. The special character of the variety is lodging tolerance. It has long, erect deep green flag leaf. BRRI dhan70 can produce 4.8-5.0 t/ha yield with proper management which is approximately 1.0-1.35 t/ha higher yield than BRRI dhan37. The exportable aromatic rice BRRI dhan70 is an excellent variety for cultivating in the wet (T. Aman) season and farmers can be benefited by the cultivation of BRRI dhan70.

Key words: Rice, extra-long-slender, aromatic, exportable, BRRI dhan70, wet season.

1. Introduction

Aromatic rice (*Oryza sativa* L.) is identified for its distinctive fragrance when processed and cooked. This is an extraordinary group of rice, which is considered best in quality and cooked in special occasion. Aromatic rice varieties draw higher price in market than the 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 internal consumption and export [1]. Despite the mostly favorable agro-climatic conditions, aromatic rice is cultivated in less than 2% of the countrywide rice acreage of Bangladesh [2]. It was calculated that, more than 4 thousand landraces of rice are adopted in different parts of Bangladesh. Only some of these are unique for quality traits including fineness, aroma, taste and protein contents [3].

Most of the premium quality rice cultivars are lower

yielding [4]. There are few locally adapted premium quality rice varieties namely Chiniatop, Kalizira and Kataribhog. Bangladesh Rice Research Institute (BRRI) released few premium quality modern rice varieties like BR5, BR34, BRRI dhan37, BRRI dhan38 and BRRI dhan50. These varieties are also exportable after satisfying local demand. It was estimated that aromatic rice varieties have occupied about 12.5% of the total transplant Aman rice cultivation area [5].

Aromatic rice production in Bangladesh is getting to be popular because of its high costs and export prospect [6]. Right now, it is favored by more customers regardless of their cost. In the financial 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 crucial role in rice breeding. It is vital to know the physiological behavior and genetic expression of the selective modern and aromatic rice cultivars for definite breeding objectives to improve those cultivars. Distinguishing promising morpho-physiological characteristics related with quality and yield plays a

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critical role in varietal improvement programs. The quality in rice is viewed as dependent on processing or milling quality, grain size and shape, appearance, fragrance and other cooking attributes [8].

A large portion of the consumers incline toward fine rice varieties with great cooking quality that have aroma. Because of special flavor and taste, aromatic rice is profoundly demanded 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 development [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 amid T. Aman season. Islam et al. [12] observed that the yield of aromatic rice was low (1.5 to 2.0 t/ha) however its high cost and minimal effort of development produced higher overall revenues contrasted with other rice cultivars. There are nearly 3,000-5,000 local cultivars under cultivation in Bangladesh [13].

Yield and quality of rice rely upon the hereditary capability of cultivars, encompassing environment and the management practices. Selection of right type of variety is most vital components for expanding rice production. Yield of rice changes because of growing condition, for example, different locations, seasonal fluctuations, distinctive dates of planting and so forth [14]. It is, therefore, to evaluate the performance of aromatic rice varieties through appropriate cultural practices to get maximum yield and quality in multi-locations trial is very important.

Development of rice cultivars with a high yielding ability is one of the most fundamental approaches for

dealing with the expected increase in the world demand [15]. There is a lot of research information on specific rice variety, but a little is documented on comparative study of morpho-physiological characters of rice cultivars during Aman season in Bangladesh. This research work gives an account of growth and yield performance of a new high yielding aromatic fine rice variety and describes 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 dhan70.

2. Materials and Methods

BRRI dhan70 was developed from a single cross between IR67423-208-6-2-3-3 and IR65610-105-2-5-2-2-2 in the year 2002 with the aim of improvement of BRRI dhan37 and development of an aromatic and premium quality rice variety in BRRI Gazipur. The pedigree of BRRI dhan70 is BR7357-11-2-4-1-1. The F₁ plants were grown in 2003 in the net house of BRRI along with respective parents. The cross was confirmed and registered as BR7357. The next year disease and insect free, lodging resistant belonging to long slender grain along with strong plants were selected in F₂ population. Pedigree selection method was followed for handling of the segregating generations within and among the rows in F₃-F₄ generations. Some homozygous progeny lines with desirable characteristics were isolated in F₅ generations. During the period of generation advance, progeny rows were selected which were resistant against diseases and insects under field condition. In 2008, 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 2010, the sister lines of the advanced breeding materials were tested for Preliminary Yield Trial (PYT) for primary

yield evaluation. Then after proper selection in 2011, promising sister lines were tested in Secondary Yield Trial (SYT) for confirmation of the yield of the materials in the Gazipur 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 nine regional station of BRRi in randomized complete block (RCB) design with three replications in T. Aman 2012. After proper yield evaluation one material (BR7357-11-2-4-1-1) 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 2013, 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 were taken from 10 sq-m sample plot in each replication. In T. Aman 2014, BR7357-11-2-4-1-1 (BRRi dhan70) was evaluated by the National Seed Board of Bangladesh (NSB) in the nine locations of farmers' field of Bangladesh in Proposed Variety Trial (PVT). Finally after proper evaluation the NSB team found BR7357-11-2-4-1-1 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 dhan70 in the year 2015.

The data analysis of the experiments was done with software namely STAR, PBTools and Microsoft excel 2013 [16-18]. A schematic diagram has been illustrated about BRRi dhan70 development (Fig. 1).

IR67423-208-6-2-3-3 × IR65610-105-2-5-2-2-2

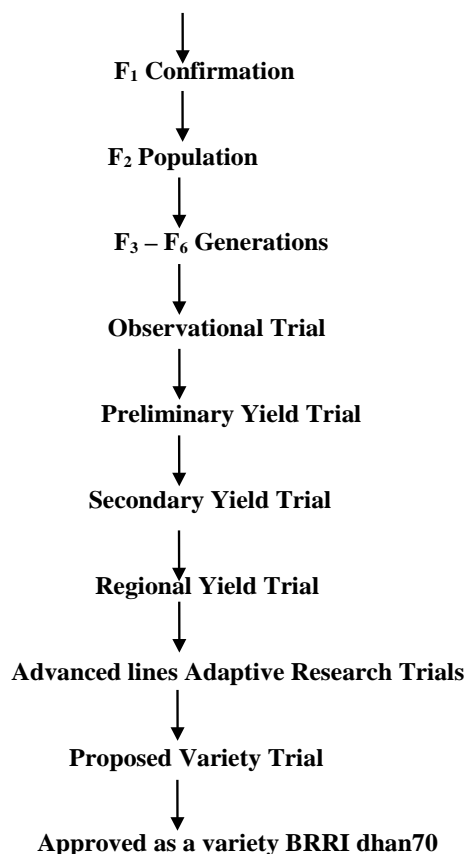


Fig. 1 Schematic diagram for development of BRRi dhan70.

3. Results and Discussion

The agro-morphological characteristics of BRRI dhan70 is shown in Table 1. It has moderate plant height with BRRI dhan37 which indicates lodging tolerance. BRRI dhan70 has erect, long, deep green flag leaf which facilitates maximum solar light uptake. Its panicle length is also longer than BRRI dhan37. The regional yield trial of this line was conducted in five BRRI Regional stations of Bangladesh. BR7357-11-2-4-1-1 showed the maximum yield (3.47 t/ha), followed by BI dhan1 (Table 1). High yield is the prime objective

in developing modern rice varieties. BRRI dhan70 showed higher yield than the all other varieties in T. Aman 2012. This higher yield of BRRI dhan70 was due to its genetic potentiality of producing higher and longer grains per panicle than BRRI dhan37. Growth duration of BRRI dhan70 was found 23 days earlier than BRRI dhan37.

In Radar graph, the highest yield was found in Kustia with 4.21 t/ha followed by 3.80 t/ha in Cumilla and 3.40 t/ha in Gazipur. The grain yield of BRRI dhan70 is about 0.33 t/ha higher than BRRI dhan37 (Fig. 2).

Table 1 Morphological and agronomic characteristics of BRRI dhan70, on-station Regional Yield Trial, T. Aman 2012.

SN	Designation	Plant height (cm)	Locations											
			Gazipur		Cumilla		Rajshahi		Kushtia		Rangpur		Mean	
			GD	GY	GD	GY	GD	GY	GD	GY	GD	GY	GD	GY
1	BR7357-11-2-4-1-1	122	133	3.40	131	3.80	132	2.61	134	4.21	132	3.34	132	3.47
2	BR7044-1-5-1	110	128	2.52	129	3.90	128	2.19	128	4.29	125	3.38	128	3.26
3	BI dhan1	98	121	2.60	129	3.80	120	3.63	124	3.82	124	3.15	124	3.40
4	BI dhan2	91	105	1.95	105	3.30	106	2.03	108	3.67	107	2.95	106	2.78
6	BRRI dhan34 (Ck)	138	139	2.60	147	3.60	140	1.99	142	3.75	150	3.60	144	3.11
7	BRRI dhan37 (Ck)	145	147	2.55	155	3.70	150	1.76	150	4.12	157	3.57	152	3.14

GD = Growth Duration; GY = Grain Yield.

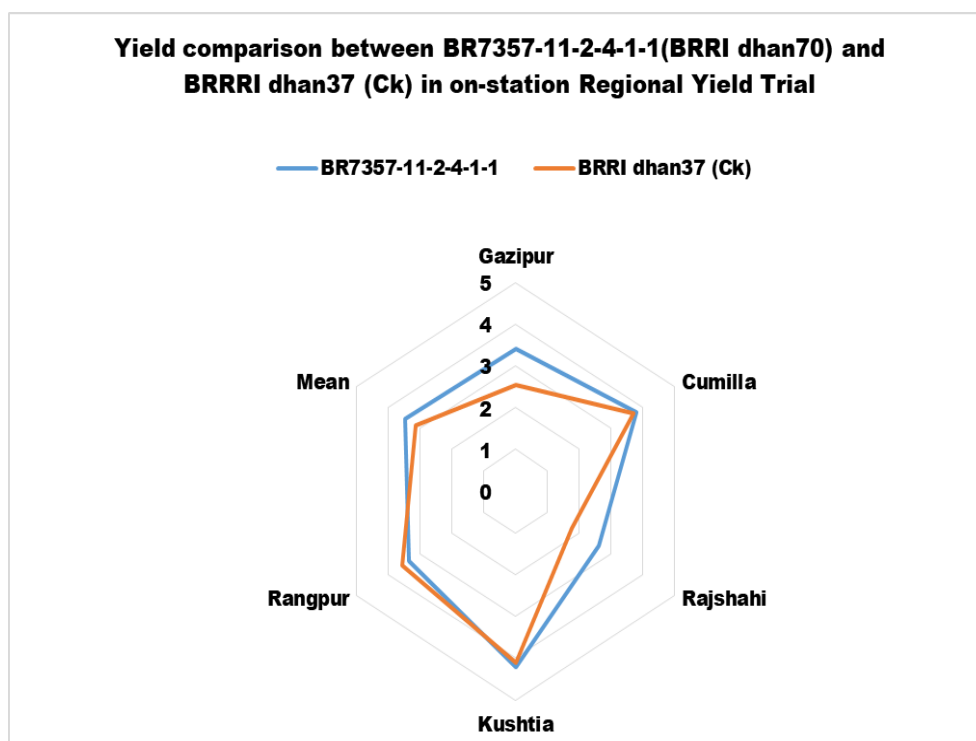


Fig. 2 Location-wise grain yield comparison between BR7357-11-2-4-1-1(BRRI dhan70) and BRRI dhan37 (Ck).

BR7357-11-2-4-1-1(BRRI dhan70), one advanced line and check variety BRRI dhan37 were evaluated in 8 locations in the farmers' field of Bangladesh. Results are shown in Table 2 and Fig. 3. The significant variation was found for grain yield of the genotypes. Highest grain yield of was found for BR7357-11-2-4-1-1 (5.18 t/ha) followed by BR7357-11-2-4-1-1 (5.15 t/ha) and BRRI dhan37 (3.96 t/ha). Highest grain yield potentiality was found for BR7357-11-2-4-1-1 in Barishal (5.18 t/ha) and that of BRRI dhan37 was found in Rajshahi with 3.96 t/ha (Fig. 3). The result visualizes the higher yield potentiality of BRRI

dhan70 over the check genotype. On an average BRRI dhan70 yielded 1.03 t/ha higher than BRRI dhan37. Although BRRI dhan70 gave the highest (314) panicle/m² than BRRI dhan37 (298), the 1,000 grain weight of BRRI dhan70 showed significant variation with BRRI dhan37. Both the materials were more or less affected by diseases and insects in different locations. Stem borer and rice bug infestation was higher (10-15%) in Dinajpur and minimum in Barisal. All the genotypes were almost disease free in some locations with little diseases which were found in some other locations. The strong plant stature (125 cm)

Table 2 Performance of the BR7357-11-2-4-1-1 (BRRI dhan70) at different zonal trial in farmers' field, T. Aman 2013.

Designation	Plant height (cm)	Growth duration (days)	Yield (t/ha)								
			Gaz	Com	Bar	Chi	Ran	Syl	Raj	Jess	Mean
BR7357-11-2-4-1-1 (proposed variety)	125	130	5.15	4.06	5.18	4.93	4.64	4.80	4.85	3.55	4.65
BRRI dhan37 (Ck)	125	139	2.99	3.92	3.56	3.79	3.70	3.53	3.96	3.48	3.62
LSD (0.05)	ns	5.60	1.82	ns	1.10	0.87	0.98	0.65	0.63	ns	0.89

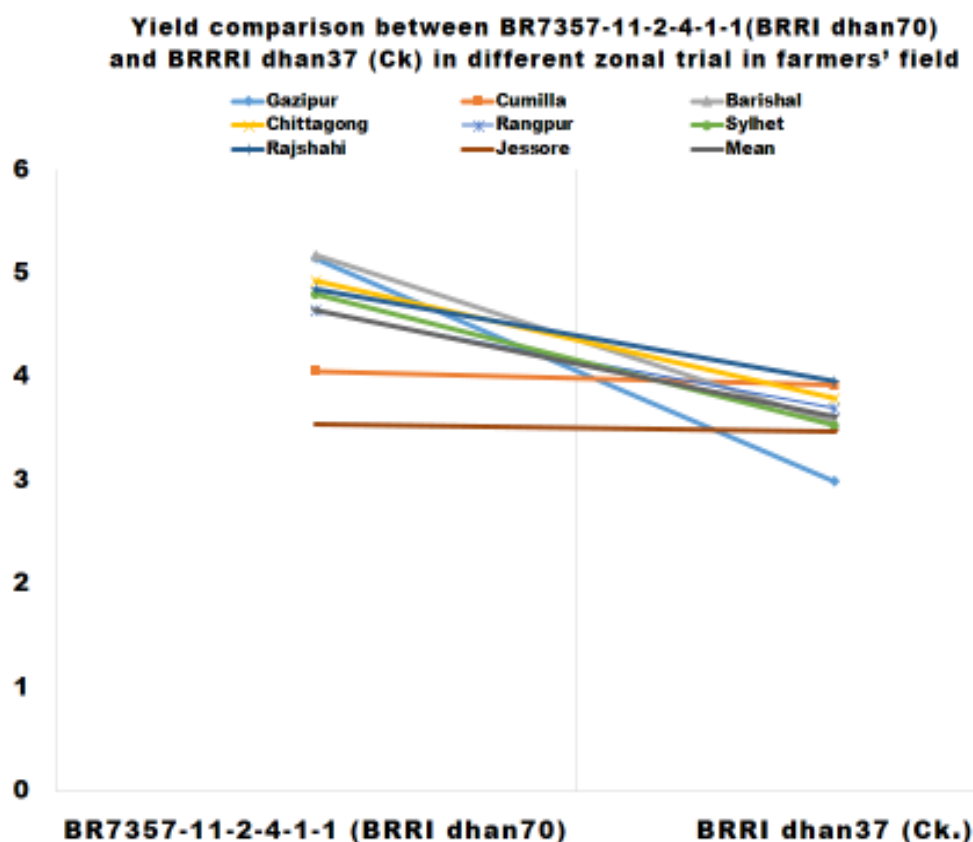


Fig. 3 Yield performances of proposed lines in eight locations of Bangladesh.

of the variety made it lodging tolerant. Growth duration was found 09 days earlier than the check variety BRRI dhan37. Farmers preferred BR7357-11-2-4-1-1 for their better yield, shorter growth duration and importantly lodging tolerance as well as extra-long slender grain quality, in spite of having some negligible diseases in some areas.

Performance of the BR7357-11-2-4-1-1 (BRRI dhan70) at on farm trial, T. Aman, 2014 is shown in Table 3. Evaluation of the BR7357-11-2-4-1-1 (BRRI dhan70) at on farm trial was performed by the National Seed Board (NSB) of Bangladesh in T. Aman 2014 season. The highest yield of the genotype was found with 5.63 t/ha in Feni followed by in Habigonj with 5.33 t/ha, 5.07 t/ha in Rangpur. The grain yield indicated that the variety could produce more with proper crop management. The grain yield range of BRRI dhan37 (Ck) was found from 1.68-4.41 t/ha. On an average BRRI dhan70 produced 4.77 t/ha yield where as BRRI dhan37 produced 3.39 t/ha yield, that is 1.38 t/ha higher for the variety (Fig. 4). Growth duration of BRRI dhan70 was ranged from 119 days in Rajshahi to 140 days in Feni depending on the agro climatic situation in the T. Aman season. Mean growth duration of the variety was found 130 days which is 14 days earlier than the check variety BRRI dhan37 (Table 3).

Additive Main effects and Multiplicative Interaction (AMMI) model shows only environmental interaction for predicted potentiality of breeding line. According to AMMI Biplot, the BRRI dhan70 is the best performer in Rajshahi (E1) followed by in Barishal (E4). It will perform constantly in Kushtia (E3), Habiganj (E7) and Satkhira (E8). BRRI dhan70 will comparatively less perform in Cumilla (E6) (Fig. 5).

The What-won-where Biplot analysis indicates BRRI dhan70 (G1) was higher yielder than BRRI dhan37 (G2) among ten trial locations (Fig. 6).

An Adaptation Map was constructed using data from nine farmer's field trial, the analysis predicts that BRRI dhan70 is likely to be more adapted variety than the BRRI dhan37 in anywhere of trial locations (Fig. 7).

BRRI dhan70 produced optimum and higher yield when it is transplanted in second week of August (14 August) and growth duration is also 133 days. If it is transplanted in 1 September then it produces 3.70 t/ha with 124 days and other transplanting dates are not suitable for BRRI dhan70. So the perfect date of transplanting from second week of August to first week of September (Table 4).

BRRI dhan70 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

Table 3 Performance of the BR7357-11-2-4-1-1 (BRRI dhan70) at Proposed Variety Trial in farmers' field, T. Aman, 2014.

Location	Proposed variety		Check	
	BR7357-11-2-4-1-1		BRRI dhan37 (Ck)	
	Growth duration (days)	Grain yield (t/ha)	Growth duration (days)	Grain yield (t/ha)
Rajshahi	119	3.49	153	1.68
Rangpur	125	5.07	150	3.50
Kustia	129	4.99	147	3.26
Barisal	130	4.32	147	2.57
Feni	140	5.63	148	3.55
Comilla	128	4.93	137	4.41
Habigonj	134	5.33	139	4.06
Satkhira	120	4.44	140	3.30
Mymensingh	136	4.62	142	3.73
Gazipur	135	4.92	140	3.85
Mean	130	4.77	144	3.39

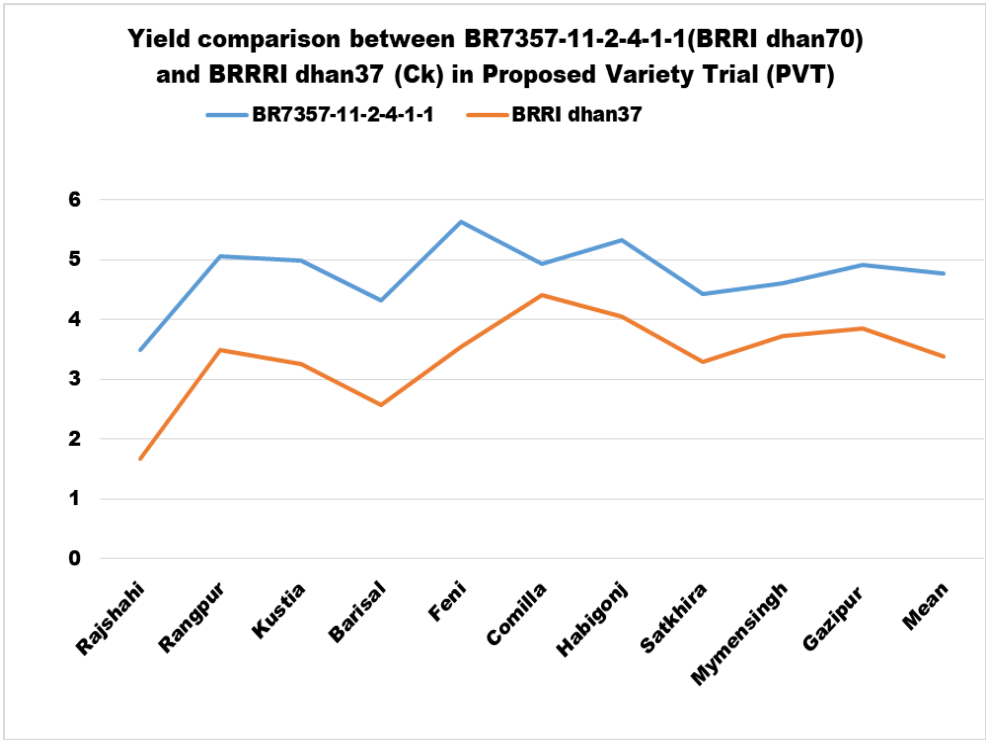


Fig. 4 Yield performances of proposed line in ten locations of Bangladesh.

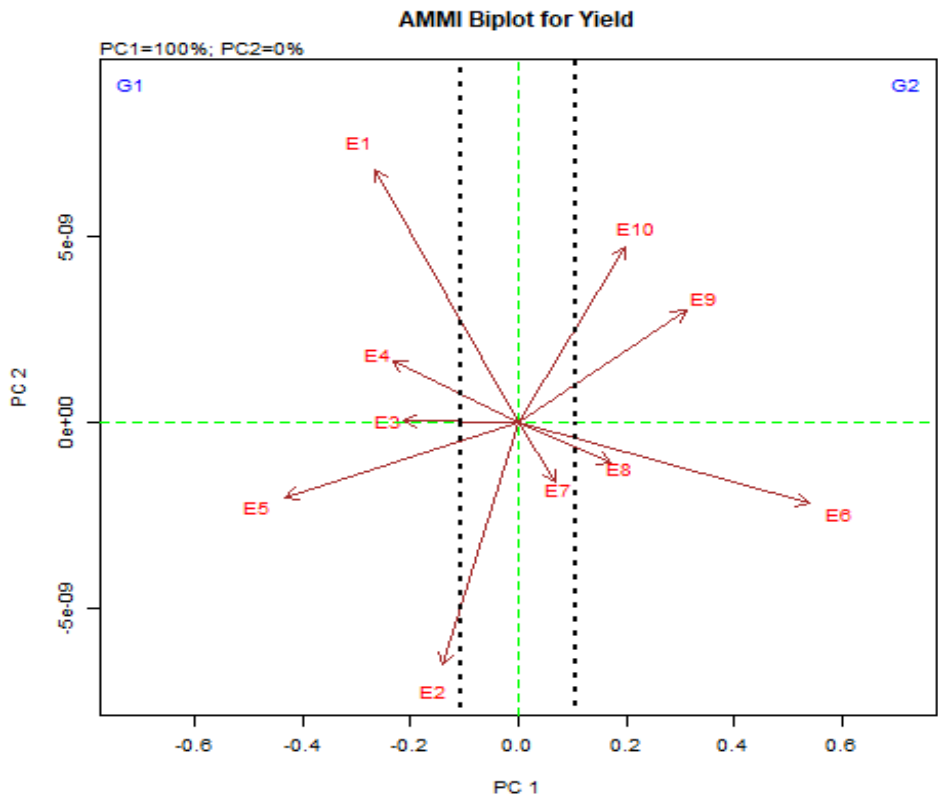


Fig. 5 AMMI Biplot analysis showing the environmental interaction to genotypes.

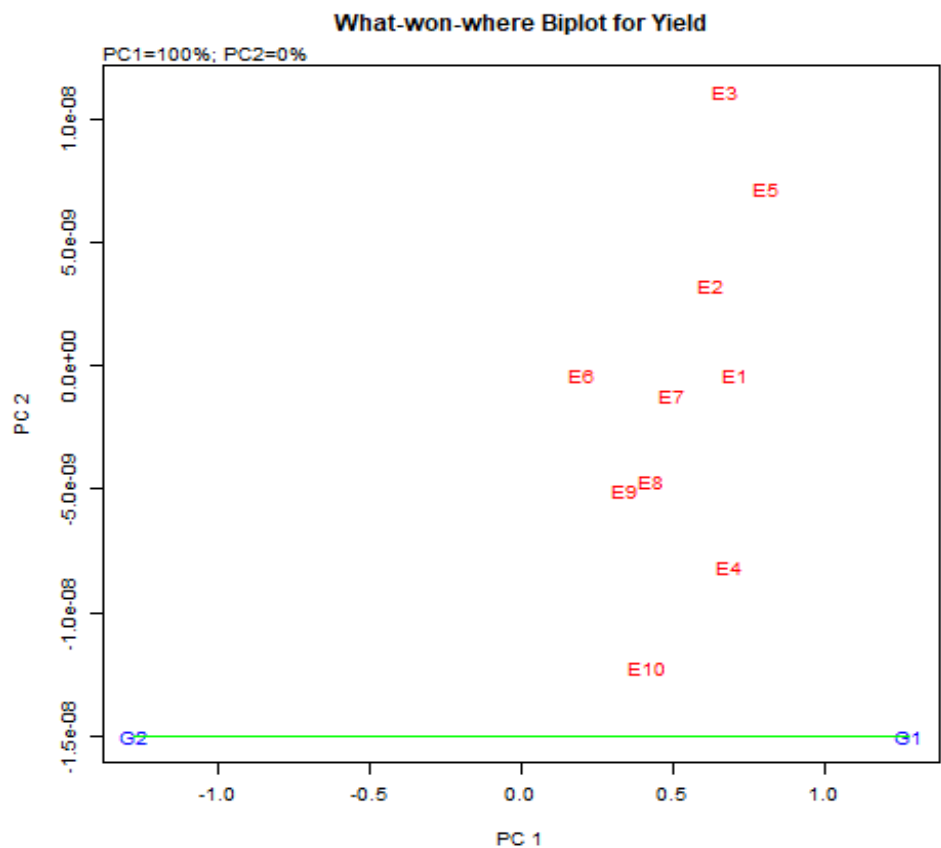


Fig. 6 What-won-where Biplot analysis shows the better performance of BRRI dhan70 in each trial location.

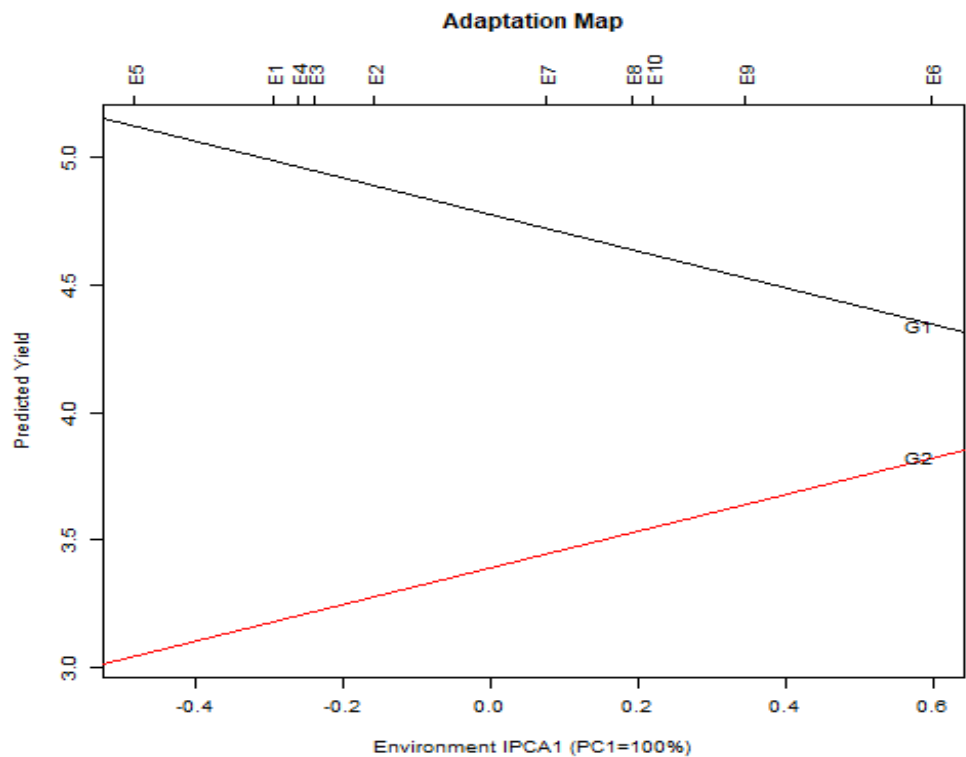


Fig. 7 Adaptation map of BRRI dhan70.

Table 4 Effect of planting time on yield (t/ha) and growth duration (in the parenthesis) of the proposed variety.

Designation	Date of transplanting			
	14 August	01 September	22 September	02 October
BR7357-11-2-4-1-1 (BRRI dhan70)	3.8 (133)	3.7 (124)	1.52 (120)	Not flowered
BRRI dhan37 (Ck)	3.5 (144)	3.0 (139)	1.6 (127)	1.6 (126)

Table 5 Reaction of the BRRI dhan70 against major diseases and insects under natural field condition, T. Aman 2013.

Designation	BB	ShB	Blast	DH	WH
BR7357-11-2-4-1-1	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).

Table 6 Physicochemical properties of BRRI dhan70.

Designation	Milling yield (%)	Head rice yield (%)	Decorticated grain				ER	IR	Protein (%)	Amylose (%)
			Length (mm)	Breadth (mm)	L-B ratio	Size and shape				
BR7357-11-2-4-1-1	70.2	61.9	6.2	1.4	4.4	ELS	1.5	3.4	9.5	21.7
BRRI dhan37 (Ck)	70.0	64.9	5.4	1.7	3.2	MS	1.2	3.7	10.3	23.8

*IR: Imbibition Ratio; ER = Elongation Ratio.

**Fig. 8** Pictorial view of BRRI dhan70 (BR7357-11-2-4-1-1) in the field condition.

blight. The variety is found resistant to sheath blight disease and Blast (Table 5). 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.

BRRI dhan70 is an extra-long slender grain having length-breadth ratio 4.4 which is higher than that of

BRRI dhan37. The milling outturn of the variety is 70.2% with the head rice recovery 61.9% which is similar to the check variety (Table 6). BRRI dhan70 is straight and it could be milled in any kind of milling machine. This result revealed that BRRI dhan70 will get high market price because of aromatic, extra-long slender, premium quality brand polish rice. The

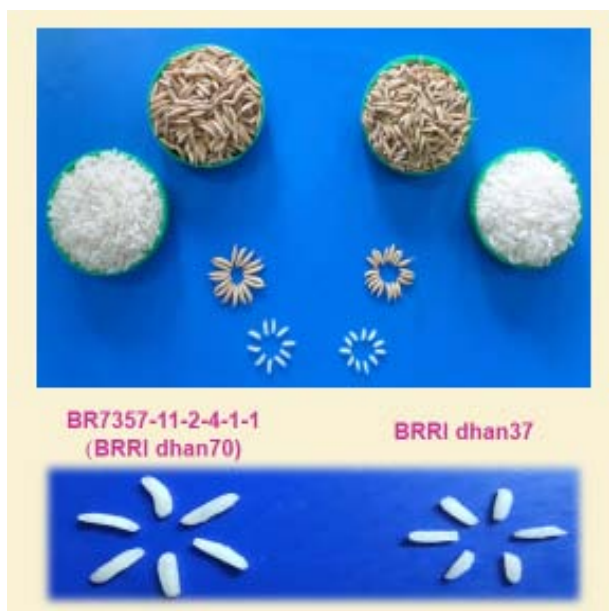


Fig. 9 Pictorial view of rough rice, unparboiled rice and cooked rice of BRRi dhan70.

protein and amylose percentage of BRRi dhan70 is 9.5 and 21.7% (Table 6). The important feature is the higher elongation ability of the cooked rice of BRRi dhan70 than BRRi dhan37. The physicochemical property of BRRi dhan70 presented in Table 9 represents the fine quality rice nature of BRRi dhan70. So Bangladesh could earn foreign currency by exporting the rice of BRRi dhan70.

The characters like deep green leaf, erect flag leaf, long slender aromatic grain with colored tip having pointed awn are 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 BR7357-11-2-4-1-1 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, BR7357-11-2-4-1-1 has been released as BRRi dhan70 in the year 2015. The pictorial view of BRRi dhan70 in the field condition with its grain, rice and cooked rice is shown in Figs. 8 and 9.

4. Conclusions

In conclusion, BRRi dhan70 was released as a high yielding, aromatic, extra-long slender and premium quality rice variety. Adaptability tests of this variety under multi-location trials in the farmers' field showed satisfactory performance 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) after harvesting this variety and thus it will also increase total productivity.

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