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Development of Submergence Tolerant Rice Variety BRRI dhan79 for Flash Flood Ecosystem of Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Tolerance to submergence stress is an important breeding objective for the areas where rice cultivars are subjected to complete inundation for a week or more. Submergence tolerance is an important trait for rice (*Oryza sativa* L.) in the flash flood-prone ecosystem. The trait is largely controlled by a major gene designated as *Sub1* located on chromosome 9. Submergence of rice (*Oryza sativa*) by flash flooding is a major constraint to rice production in Bangladesh. Quantitative trait loci analyses have revealed that a large portion of this variation in submergence tolerance can be explained by *Sub1*. A newly released submergence tolerant rice variety namely BRRI dhan79 was developed by hybridization between BRRI dhan49*6/BRRI dhan52 through Marker Assisted Backcrossing and selection method where BRRI dhan52 (submergence tolerant mega variety in Bangladesh) used as *Sub1* donor. It can tolerate upto three weeks complete submergence at vegetative stage whereas Sub1 donor mega variety BRRI dhan52 can tolerate on an average two

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weeks complete submergence condition. It can also tolerate 50-60 cm water stagnation for 15-20 days after de-submergence. The variety has satisfactorily been passed in the proposed variety trial conducted in flash flood prone farmers' field in Bangladesh. As a result, the National Seed Board (NSB) of Bangladesh approved this rice variety for commercial cultivation for the flash flood affected rainfed lowland ecosystem (Transplanted Aman season) in 2017. It meet up all the trait of modern plant likely medium plant heihght (112 cm), strong and stature culm structure, erect flag leaf with stay green leaf at maturity stage and high yield potential with 140 days growth duration (in case of three weeks submergence mature by 160 days). It can produce 5.5 t/ha grain yield under non-stress condition and 4.0-4.5 t/ha yield under three weeks submergence condition. The grain shape of the variety is medium bold. The rice production scenario in flash flood affected region of Bangladesh has been remarkably improved after releasing this rice variety. It has not only change the socio-economic status of farmers but also sustaining food security.

Keywords: Submergence; rainfed ecosystem; Sub1; BRRI dhan79; vegetative stage; flash flood; stagnant water.

1. INTRODUCTION

"More than 2.0 million hectare areas of Bangladesh are affected by different grades of flash floods" [1]. "Submergence can result in yield losses of up to 100% depending upon different factors of the environment. Submergence stress is estimated to affect about 20 million ha of rice-*growing* areas in Asia" [2]. "Traditional rice varieties cultivated under this ecosystem were not feasible due to its very low grain yield with undesirable agronomic traits and submergence susceptibility. To overcome this situation, submergence tolerant with higher yield potential rice varieties are burning needs to increase the productivity of the submergence prone areas of Bangladesh. The discovery of comprehensive molecular linkage maps enables us to do the pyramiding of *Sub1* gene in high yield background rice varieties" [2].

"Flash flood during the monsoon (mid-June to mid-August) severely limits rice production in South and Southeast Asia, causing annual losses of over one billion U.S. dollars. On an average one million hectare of rice cultivated area is highly affected by flash flood and five million hectares are moderately affected area. More than 18 districts of Bangladesh are more or less regularly affected by different grades of flash floods. Moreover, flash floods regularly affect rainfed lowland rice ecosystems. About 2.6 million hectares of rice lands of Bangladesh are affected by excess water for incessant rainfall in Monsoon season and periodically suffer from flash floods with complete submergence for 1-2 weeks or more covering about 24% of the total rice areas. This flood causes enormous damage to rice crop and irreparable yield loss (10-100%) depending on water depth, duration of submergence, the turbidity of the water, light intensity and age of the crop, etc" [3,4,5].

[2] It was reviewed that "plants require water for growth but excess water that occurs during submergence or waterlogging is harmful or even lethal. Among the rice-growing ecosystems, rainfed lowland is the most challenging one concerning the prevalence of many abiotic and biotic stresses. Submergence is the most important abiotic stress in the Rainfed Lowland Rice (RLR) ecosystem".

"The *Sub1* QTL on chromosome 9 accounts for 70% of the phenotypic variation for survival under submergence has been fine mapped on chromosome 9 and the cluster of genes underlying this QTL has been cloned and successfully introgressed into a number of high yielding background rice varieties (Swarna, Shambamashuri, Chehrang, IR64, BR11, CR1009 and Thadokkam 1 etc.) by International Rice Research Institute (IRRI) and Bangladesh Rice Research Institute (BRRI)" [1,2,3,6,7,8]. "A large scale marker-assisted backcrossing (MABC) program was undertaken at IRRI to incorporate the *SUB1* gene into several popular rice varieties ("mega-varieties") that had many desirable attributes such as high yield and superior grain quality but were deficient in submergence tolerance. The *SUB1* gene conferred tolerance to complete submergence in rice for approximately 10 to 18 days. Using a high level of precision in MABC, the essential features of the mega-varieties (i.e. yield, grain quality, agronomic traits) were retained" [1,2,6].

[6] It was reported that "flooding is a natural calamity that destroys the production of rice throughout the world especially in low-lying

areas, but all economically important varieties are not tolerant to flash flood. Identification of the *SUB1* QTL enables the scientist to introgress this QTL by MAB into the popular high-yielding varieties". [9] It was reviewed that "SSR markers, which were polymorphic between two parents, were generally used for the background confirmation of recurrent parent genome conformation also well combined with the Sub1 region originated from FR13A on chromosome 9. Normally newly developed Sub1 lines show more enhanced submergence tolerance compared to parents which are being obtained through phenotypic evaluation. These studies show the opportunities for the insertion of the Sub1 region from developed tolerant variety through MAB to produce tolerant varieties with a diverse genetic background. Furthermore, the effect of *SUB1* on other agronomical characteristics of the plant such as grain quality, growth, maturation, and grain production was determined in IR64-Sub1, Swarna-Sub1, and Sambha Mahsuri-Sub1. Further research of the above-mentioned submergence tolerant varieties and their original parents revealed that the insertion of the Sub1 gene does not alter yield performances including quality and yield of grain under normal non-flooded condition".

[10] It was reported that "complete submergence of susceptible varieties at the different growing stage considerably reduces the yield attributes like the number of panicles, the total number of grains per panicle, and grain filling percentage of the plant and also flowering and maturity may be delayed, resulting in a remarkable decline in yield. On the other hand, a Sub1 rice variety minimizes the total yield reduction by flood and produces more yield than the intolerant varieties at the submerged condition. One of the main advantages of using this approach is that the newly developed Sub1 varieties retain almost all agronomical characteristics of the recurrent parent, especially in terms of yield and quality. Sub1 varieties produced from FR13A-derived varieties have almost the same yield, agronomical, and grain quality characteristics as recurrent parent varieties when grown under regular conditions, but, when subjected to flooding for 1 to 2 weeks, Sub1 varieties showed a remarkable advantage in terms of yield than the susceptible ones".

[4] It was reviewed that "mega varieties that have *SUB1* gene, can be adopted by the farmer easily, besides, these new varieties can replace the traditional landraces with low yielding, and currently which has been used by the farmers in flood-prone areas. Some tolerant lines were evaluated and adopted in low-lying areas in more than ten countries in South and Southeast Asia, in field trials as the preferences of the farmers. The good yield performance of newly developed varieties, showing the better performance of Sub1 against flooding or submergence of rice. Those performances of the newly developed varieties have influenced a lot of rice improvement programs in Asia and Southeast Asia to perform rapid seed multiplication and dissemination schemes".

[11] It was reported that a "submergence tolerant high yielding variety was developed using BR11 as recipient parent applying foreground, phenotypic and background selection approaches. The recombinant selection was found essential to minimize linkage drag by BC_2F_2 generation. Without recombinant selection, the introgression size in the backcross recombinant lines (BRLs) was approximately 15 Mb on the carrier chromosome. The BRLs were found as submergence tolerant compared to the check varieties under complete submergence for two weeks at Bangladesh Rice Research Institute (BRRI). The BRLs produced higher yield compared to the isogenic Sub1-line under controlled submerged condition. The Backcross Recombinant Line IR85260-66-654-Gaz2 was released as BRRI dhan52 in 2010 which was the first high yielding submergence tolerant variety in Bangladesh. BRRI dhan52 produced grain yield ranging from 4.2 to 5.2 t/ha under different flash flood-prone areas of Bangladesh in three consecutive seasons".

"New high-yielding and adapted breeding lines derived from FR13A including IR49830 and IR40931 were developed at IRRI in the early 1990s. BRRI has developed two submergence tolerant rice varieties viz. BRRI dhan51 and BRRI dhan52" [11]. These two submergence tolerant varieties can withstand around two weeks of complete submergence under natural flash flooding situation. The challenge is to increase the level of flash flooding tolerance from 2 weeks to at least 3 weeks possibly through pyramiding another QTL conferring submergence tolerance along with *SUB1*. Modern rice varieties with an increased level of submergence tolerance are required to be developed as the currently available submergence tolerance varieties are sometimes died in the farmers' field where the intensity of stress taken place is more. The alternate source of *SUB1*QTL needs to be

found out from the germplasm which will have the submergence tolerance as like as the reference resistant check FR13A but essentially will not possess the QTL *SUB1*. In this connection, [12] identified some germplasm having the similar properties of which the landrace Kalojoma is the most potential one.

The main objective of this study is to evaluate agronomic parameters of submergence and stagnant flood-tolerant rice variety BRRI dhan79 under the controlled and natural condition and its suitability for submergence prone flash flood ecosystem. The multi-location yield trials in multiple years demonstrated that BRRI dhan79 is more submergence tolerant rice variety than the existing one. During the procedures of releasing breeding line BR9159-8-5-40-14-57 as a submergence tolerant variety BRRI dhan79, the yield and other parameters were observed very intensively in this study.

2. MATERIALS AND METHODS

Modern submergence tolerant high yielding rice variety (BRRI dhan79) is developed through molecular marker-assisted backcrossing (MABC) technique of a cross between two elite varieties namely BRRI dhan49 (BR4962-12-4-1/IR33380-7-2-1-3) and *Sub1* donor mega variety BRRI dhan52 (BR11*3/IR40931-33-1-3-2-654-Gaz). The pedigree of BRRI dhan79 is BR9159-8-5-40-14-57. The crossing was done in 2009 and advanced yield trials were conducted in the different submergence prone areas of Bangladesh until 2016.

A Participatory Variety Selection (PVS) trials was conducted as Regional Yield Trial (RYT) with susceptible check variety BRRI dhan49 and submergence tolerant mega variety BRRI dhan52 under the frequently flash flood-prone on-farm stress condition (Badarganj; Rangpur and Kurigram) and on-station control stress condition (BRRI Submergence tank Gazipur and Rangpur) by following Randomized Complete Block (RCB) design with three replications during T. Aman 2015 (Table 1). PVS function was arranged at each location irrespective of occurrence of flash flood with the gathering of 15 male and 15 female farmers,5 researchers, 5 agricultural extension personnel and 5 rice miller and seed dealers. Each participant apply their opinion to select the upcoming rice variety for flash flood prone ecosystem of by casting three votes for best performing (positive) genotypes and three votes for worst (negative) performing genotypes including all three checks variety. It also mentioned that, participants apply their votes based on survivability (%), grain yield, growth duration, grain size and shape and other phenotypic acceptance. Preference score and ranking were considered to select best performing genotypes for next step trail using the below formula.

Preference score =

$$\frac{\text{Total no. of positive votes} - \text{Total no. of negative votes}}{\text{Total no. of votes}}$$

In parallel, Advanced Lines Adaptive Research Trial (ALART) also conducted in same year (2015) to evaluate specific and general adaptability with standard checks BRRI dhan49 and BRRI dhan52 in on-farm (farmers' field) condition of flash flood-prone area by Adaptive Research Division (ARD) of BRRI. This genotype was tested for different physic-chemical properties, cooking qualities, disease-insect reactions under artificial conditions. The plant height and other agronomic traits were recorded from ten randomly selected plants of each replication by excluding border plant. Growth duration was counted from seeding to 80% grain maturity. Whole plot (20 sqm) grain yield data was recorded from each replication. Based on previous year PVS and ALART trial, best performing genotypes BR9159-8-5-40-14-57 (BRRI dhan79) was evaluated with two standard checks BRRI dhan49 and BRRI dhan52 in Proposed Variety Trial (PVT) by the National Seed Board (NSB) of Bangladesh in eight locations of farmers' field and two locations of controlled submergence condition during T. Aman 2016.

3. RESULTS AND DISCUSSION

In T. Aman 2015, PVS and ALART trials were full submerged by natural flash flood for two times. 1st flash flood was occurred after 45 days of plant age with 100-180 cm water depth. 1st flash flood (16 days) water was de-submerged and remaining 40-55 cm stagnant water for 15-20 days. After 15 days of submergence recovery period, second flash flood affect for 4 days with 130-150 cm water depth at late vegetative stage (just before panicle initiation stage) at most of the location. In PVS trial, the advanced genotypes BR9159-8-5-40-14-57 gave highest yield (4.59 t/ha) and survivability (76%) with 157 dyas growth duration. Where as best performing resistant check variety BRRI dhan52 gave 3.96 t/ha grain yield and 59 % survivability with 160

days growth duration. Other genotypes performance in this PVS trial were presented in Table 1. In PVS preference analysis, genotypes BR9159-8-5-40-14-57 ranked 1st position, BR9159-8-5-40-13-52 ranked 2nd position and tolerant checks BRRI dhan52 ranked 3rd position. In this trial we found the heritability for plant height, growth duration, survivability (%) and over the location average grain yield 91%, 45%, 39% and 58% respectively, which indicates the higher level of precision of the trial.

In ALART trial, the genotype BR9159-8-5-40-14-57 gave highest grain yield (3.48 t/ha) with 142 days growth duration. Where as BRRI dhan49 gave 3.26 t/ha grain yield and BRRI dhan52 gave 3.15 t/ha grain yield. Here, tolerant check BRRI dhan52 gave 0.11 t/ha lower grain yield than susceptible check BRRI dhan49 (Table 2). Tolerant check gave lower grain yield because of 5% -10% rat damage in most of the location and severe rat damage at Nilphamari trial. Rat damage and BPH incidence occurred in tolerant check BRRI dhan52 (BPH SES = 9) just after harvesting of comparatively earlier tested advanced line and susceptible check BRRI dhan49 in most of the location.

Based on the PVS and ALART result the tested advanced line BR9159-8-5-40-14-57 promoted to final step of yield trial Proposed Variety Trial (PVT) for T. Aman 2016. In PVT trial, the line BR9159-8-5-40-14-57 produced 5.37 t/ha grain yield which was significantly higher than the grain yield of BRRI dhan49 (4.12 t/ha). The growth duration of the tested line was around 5 days earlier than BRRI dhan52. Though under 16 days of controlled complete submergence pressure (when the plant age was around 45 days) at BRRI regional station Rangpur, the line produced similar grain yield compared to BRRI dhan52 (Table 4.a) but under 25 days of submergence pressure at BRRI Gazipur, the line produced 2.3 t/ha more yield than BRRI dhan52 and 3.1 t/ha more grain yield than BRRI dhan49 (Table 4.a). Though there were no natural flash flooding in the farmers' field trials, but, importantly, in all the locations the proposed line produced more grain yield than BRRI dhan49 (Table 4.a). Under the controlled submerged condition, BR9159-8-5-40-14-57 showed higher survivability (77% at BRRI Gazipur Tank and 95% at BRRI Rangpur Tank) under two to three weeks complete submergence when the plant age was around 45 days (Table 4.b). It is noted that the proposed line BR9159-8-5-40-14-57 has erect flag leaf which facilitates maximum solar light uptake, 1000 grain weight of this variety is 22.5 gram and possesses medium bold grain size and shape (Fig. 1), high amount of amylose (25.2%) content and late leaf senescence quality at maturity ensuring harvest of optimum yield (Table 3). Finally, the proposed line BR9159-8-5-40-14-57 was recommended to release for submergence tolerant rice variety released as BRRI dhan79 in the 92th NSB meeting held on 5 April 2017.

BR9159-8-5-40-14-57 (BRRI dhan79) showed tolerance to major diseases and insects under the natural and artificial inoculated condition. BR9159-8-5-40-14-57 (BRRI dhan79) showed similar symptoms of check varieties against different major diseases and insects' infestation (Table 5 and Table 6).

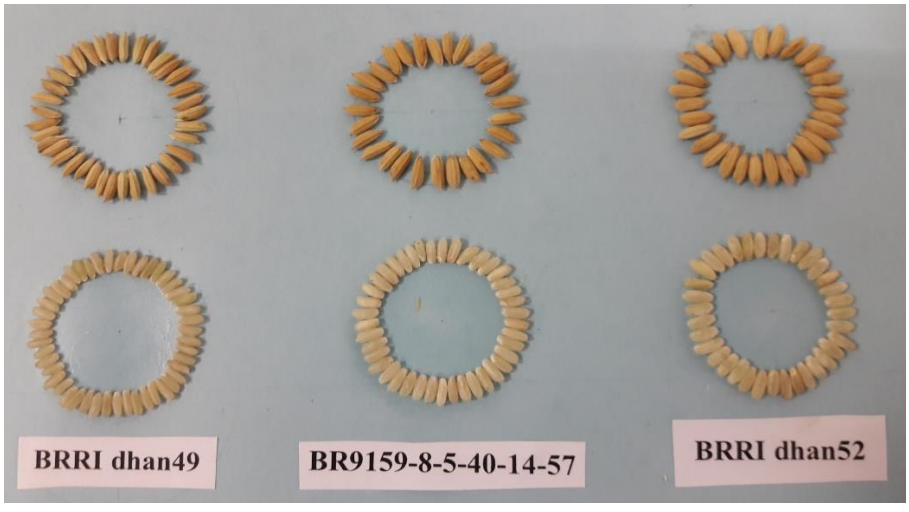

Fig. 1. Pictorial view of rice grain and dehulled grain of the proposed submergence tolerant line compared to the check varieties

Table 1. Performance of BR9159-8-5-40-14-57 (BRRI dhan79) in Participatory Variety Selection (PVS) trial under Control stress and hotspot stress condition during T. Aman 2015

SL.	Designation	Plant height (cm)	Growth duration (Days)	Survivability (%)	Grain yield (t/ha)			Farmer's preference score & rank
					Control Stress	Hotspot-Stress	Average	
1	BR9159-8-5-40-13-21	104	158	56	3.76	3.24	3.50	0.11 (6th)
2	BR9159-8-5-40-13-52	108	157	65	4.42	3.91	4.16	0.20 (2nd)
3*	BR9159-8-5-40-14-57	104	157	76	4.85	4.33	4.59	0.31 (1st)
4	BR9159-8-5-49-1-2	108	158	75	4.20	3.68	3.94	o.13 (4th)
5	BRRI dhan51 (R. Ck)	97	163	52	3.45	2.93	3.19	0.09 (7th)
6	BRRI dhan52 (R. Ck)	118	160	59	4.22	3.71	3.96	0.17 (3rd)
7	BRRI dhan49 (S. Ck)	103	153	36	3.17	2.65	2.91	0.12 (5th)
LSD (0.05)		7.23	6.61	Ns	1.13	1.34	1.24	
Heritability		0.91	0.45	0.39	0.23	0.26	0.58	

Table 2. Performance of the proposed variety at on farm trial under ALART (Flash Flood Submergence), T. Aman 2015

Location	Advanced line		Standard Check		Resistant Check	
	BR9159-8-5-40-14-57		BRRI dhan49		BRRI dhan52	
	Growth duration (days)	Grain yield (t/ha)	Growth duration (days)	Grain yield (t/ha)	Growth duration (days)	Grain yield (t/ha)
Rangpur	136	4.00	135	4.15	145	3.55
Sylhet	145	3.36	147	2.45	152	2.39
Lalmonirhat	153	2.30	155	1.89	15 8	1.63
Nilphamari	141	2.83	141	2.60	-	-
Jamalpur (Sadar)	137	4.92	137	5.22	142	5.02
Mean	**142**	**3.48**	**143**	**3.26**	**149**	**3.15**

Table 3. Grain characteristics of BR9159-8-5-40-14-57 (BRRI dhan79) and check varieties

Designation	Milling Yield (%)	Head rice recovery (%)	Decorticated grain				ER	IR	Protein (%)	Amylose (%)	1000 grain weight (g)
			Length (mm)	Breadth (mm)	L-B Ratio	Size and shape					
BR9159-8-5-40-14-57	71.7	63.3	5.5	2.3	2.3	MB	1.3	3.1	7.8	25.2	22.5
BRRI dhan49 (Standard Ck.)	70.0	65.0	5.4	2.0	2.7	SS	1.1	2.8	7.0	25.0	20.2
BRRI dhan52 (Resistant Ck.)	74.0	56.0	5.7	2.7	2.1	MB	1.5	2.8	7.3	26.8	25.4

**IR= Imbibition Ratio ER= Elongation Ratio MB= Medium Bold SS=Short Slender*

Table 4.a. Performance of BR9159-8-5-40-14-57 (BRRI dhan79) in PVT trial conducted at ten different flash flood prone areas, T. Aman 2016

Designation	PH (cm)	GD (days)	Yield (t/ha)										
			L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	Mean
BR9159-8-5-40-14-57	112	140	4.8	5.5	5.7	3.8	6.9	5.0	5.4	5.4	7.1	4.1	**5.37**
BRRI dhan49 (Standard Ck.)	110	141	4.5	4.8	5.4	3.7	6.7	4.7	5.2	4.8	0.4	1.0	4.12
BRRI dhan52 (Resistant Ck.)	128	144	5.4	5.6	6.3	4.2	5.5	5.4	6.1	5.1	7.2	1.8	5.26
LSD (0.05)	1.12												
Heritability	0.66												

L1=Mogholerbug, Sadar, Rangpur, L2=Aditmari, Lalmonirhat, L3=Kulaghat, Sadar, Lalmonirhat, L4=Palashbari, Gaibandha, L5=Batashar, Habiganj, L6=Dewanganj, Jamalpur, L7=Islampur, Jamalpur, L8=Dhobaura, Mymensingh, L9=BRRI-Rangpur (Control submergence-16 days submergence), L10=BRRI-Gazipur (Control submergence-25 days submergence)

Table 4.b. Survival % under controlled submergence condition PVT, T. Aman 2016

Sl#	Genotypes	Survival%	
		BRRI Gazipur Tank	BRRI Rangpur Tank
1	BR9159-8-5-40-14-57	77	95
2	BRRI dhan52 (Res. Ck)	23	57
3	BRRI dhan49 (Sus. Ck.)	15	4
4	Submergence	25 days with 80 cm water height	16 days with 99 cm water height

Table 5. Reaction of BR9159-8-5-40-14-57 (BRRI dhan79) against major diseases and insects under the natural condition based 4th edition of IRRI SES protocol

Designation	Bacterial Blight (Score & % incidence)	Sheath blight (Score & % incidence)	Stem borer (Score & % incidence)	Leaf folder (Score & % incidence)
BR9159-8-5-40-14-57	5 (7%)	7 (50%)	5 (11%)	7 (40%)
BRRI dhan49 (Standard Ck.)	5 (10%)	5 (35%)	5 (14%)	7 (45%)
BRRI dhan52 (Resistant Ck.)	5 (10%)	7 (55%)	5 (15%)	7 (45%)

Disease and Insect severity SES scale (1 – 9): Score 5 =4%-10%

Table 6. Reaction of BR9159-8-5-40-14-57 (BRRI dhan79) against major diseases and insects under the artificial inoculated condition based 4th edition of IRRI SES protocol

Designation	Bacterial Blight	Sheath blight	Brown Plant Hopper	White Backed Plant Hopper
BR9159-8-5-40-14-57	7 (16%)	9 (65%)	5 (10%)	5 (40%)
BRRI dhan49 (Standard Ck.)	7 (20%)	5 (45%)	7 (52%)	7 (55%)
BRRI dhan52 (Resistant Ck.)	5 (25%)	9 (65%)	9 (70%)	9 (65%)

Disease and Insect severity scale (0 – 9)

Table 7. Distinctness between BR9159-8-5-40-14-57 (BRRI dhan79) with check varieties

Sl#	Characteristics	BRRI dhan49 (Check Variety)		BRRI dhan52 (Check Variety)		BR9159-8-5-40-14-57		Remarks
		Code	State	Code	State	Code	State	
1	Penultimate leaf: pubescence of blade	3	Weak	5	Medium	3	Weak	Distinct
2	Flag leaf: attitude of blade	1	Erect	3	Semi-erect	3	Semi-erect	Distinct
3	Culm: Length	5	Medium	7	Long	7	Long	Distinct
4	Panicle: Length	7	Long	5	Medium	5	Medium	Distinct
5	Panicle: number of effective tillers in plant	7	Many	5	Medium	5	Medium	Distinct
6	Grain: wt of 1000 fully developed grains (at 12%)	5	Medium	7	High (24-27g)	5(23g)	Medium	Distinct
7	Decorticated grain: shape (Length-breadth ratio)	7	Medium slender	5	Medium	5	Medium slender	Distinct
8	Endosperm: content of amylose	3 (25%)	Intermediate (21-25%)	5 (26.8%)	High (>25%)	5 (25.2%)	High	Distinct
9	Other distinct special character (if any)	Non-Sub1 moderately submergence tolerant		Submergence tolerant		Submergence tolerant		Distinct

Distinguishing characters of the candidate variety BR9159-8-5-40-14-57 (BRRI dhan79) compared to the check varieties e.g. BRRI dhan49 and BRRI dhan52 are penultimate leaf: pubescence of blade, flag leaf: attitude of blade, culm: length, panicle: length, panicle: number of effective tillers in plant, grain: wt of 1000 fully developed grains (at 12%), decorticated grain: shape (length-breadth ratio), endosperm: content of amylose and other distinct special character (if any) (Table 7).

Uniformity: At 50% heading date-time only 0.5% off-type was observed. It indicated that the candidate variety BR9159-8-5-40-14-57 is uniform according to the UPOV standard.

Stability: In the test plots of two consecutive seasons trials, no remarkable variation and segregation were noted which implies the stability of the candidate variety.

4. CONCLUSION

To sum up, BRRI dhan79 was made available as submergence tolerant high yielding rice variety to satisfy the nation's desire. This variety's adaptability testing in the farmers' field under multiple locations trials demonstrated satisfactory performance in terms of submergence tolerance and some yield-contributing factors. BRRI dhan79 will be popular at farmers' level quickly and because of its high yielding along with submergence tolerance capability in flash flood ecosystem the total rice production will be increased.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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