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STUDY OF QUALITATIVE AGRO-MORPHOLOGICAL CHARACTERS OF *DHALIBORO* RICE (*Oryza sativa* L.) GERMPLASM OF BANGLADESH

MS Ahmed[1*] S Parveen[2] MHK Baktiar[1] and MA Siddique[1]

Address
[1]Genetic Resources and Seed Division and [2]Training Division, Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh.

Correspondence*
sharfuddin.brri@gmail.com

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Abstract

Ten similar or duplicate named *Dhaliboro* rice germplasm of Bangladesh were studied for twenty-one qualitative agro-morphological characters at BRRI during 2009-11. Only the presence and shape of penultimate leaf ligule characters showed no variations. The majority of the genotypes showed no anthocyanin color in leaf sheath (70%), weak, medium and strong intensity of anthocyanin color in basal leaf sheath (each 10%), green leaf blade color (90%), weak surface pubescence of penultimate leaf blade (80%), no anthocyanin color in auricles and collar of penultimate leaf (90%), colorless ligule of penultimate leaf (80%), white color of stigma (90%), erect blade of flag leaf (60%), erect curvature of lateral tiller (100%), no anthocyanin color in nodes (100%), very weak intensity of anthocyanin color in nodes and internodes (100%), yellowish to straw anthocyanin color of lemma and palea (100%), strong intensity of anthocyanin color in lemma and palea (100%), purple apex color of apiculus (70%), awnless (70%), distribution of awns at tip only (20%), yellowish white to straw and brown color awns (each 50%) and late and slow type of leaf senescence (100%), respectively. The dendrogram based on UPGMA clustering method, distributed the *Dhaliboro* genotypes along with BRRI dhan28 and BRRI dhan29 into three clusters for the nineteen qualitative agro-morphological traits. Cluster III was the major one with maximum genotypes (9), while cluster I consisted with BRRI dhan28 and BRRI dhan29 and cluster II consisted with only DB5, respectively. It was revealed from the result that the genotype DB2 (acc. no. 2247) and DB6 (acc. no. 4396) were found duplicate, which indicated that they were 100% similar. The genetic distance, ranging from 0.000 to 9.646, also revealed the existence of significant differences among the duplicate named *Dhaliboro* rice. The highest distances (9.646) was recorded between genotype DB1 (acc. no. 2250) and DB4 (acc. no. 180). Finally, duplicate named *Dhaliboro* rice germplasm showed exclusive variability and unique features for utilization in future breeding programme, especially regarding issues like intellectual property rights (IPRs).

Key words: Qualitative characters, *Dhaliboro* rice, Bangladesh.

Introduction

Rice (*Oryza sativa* L.) is the world's most important cereal crop and serves as the primary source of staple food for more than half of the global population (Emani et al., 2008). Historically, abundant diversified rice land races were cultivated in Bangladesh from time immemorial. It is reported that the IRRI Gene Bank contains more than 8,000 traditional rice varieties collected from Bangladesh (Hossain, 2013). But, now rice diversity is threatened in Bangladesh due to extensive cultivation of modem varieties (MVs) (Ahmed, 2010). Therefore, rice germplasm need to be utilized for maintaining its diversity in the field.

Crop land races display genetic variation for useful quantitative and qualitative characters (Harlan, 1975). Rice germplasm is not only endowed with genetic diversity but also represents a wealth of valuable genes (Sarma et al., 2003). Different agro-morphological traits (passport data) play very important roles for their characterization and varietal identification which ultimately helps rice breeder for its improvement (Laxuman et al., 2011). Exploring diversity in a land race collection is very important for identifying new genes and further improvement of the germplasm (Aggarwal et al. 2002; Brondani et al. 2006; Jayamani et al. 2007; and Thomson et al. 2007). A total of 12,487 names of rice germplasm were listed season and Thana wise in Bangladesh. It was then identified that duplicate(s) named rice germplasm were in all over the country (Hamid et al., 1982). Hence, similar and duplicate named rice germplasm need to be studied that they are duplicate or different. The identification of duplicate accessions was done exclusively on the documentation of the accessions on morphological characters (Ford-Lloyd et al., 1997). Subba Rao et al., (2013) characterized forty three agro-morphological traits of sixty-five landraces of rice for the establishment of the distinctness among landraces during kharif season of 2011 and concluded that the study will be useful for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes

for crop improvement and also to seek protection under Protection of Plant Varieties and Farmer's Rights Act. But, limited work has been done on characterization of local rice land races of Bangladesh. Therefore, systematic attempts have to be made to make a total inventory of this valuable gene pool for quantifying the availability of new useful genes of this source. Besides, it is very important to protect bio-piracy and geographical indications and issues related Intellectual Property Rights (IPRs). The present experiment was, therefore, undertaken to study the qualitative agro-morphological characters of ten duplicate named *Dhaliboro* rice of Bangladesh.

Materials and Method

Ten similar or duplicate named *Dhaliboro* rice germplasm of Bangladesh along with two popular BRRI varieties such as BRRI dahn28 and BRRI dhan29 were used in the experiment (Table 1). Thirty days old single seedling was transplanted using spacing within and between rows of 20 and 25 cm, respectively in unit plot of 4 rows each 2.7 m long for each entry during T. Aman 2009 and T. Aman 2011 seasons at BRRI Gazipur. The chemical fertilizers were applied at the rate of 60-50-40-10 kg NPKS per hectare.

Twenty one qualitative agro-morphological characters were studied and recorded using "Procedure of DUS tests for rice hybrid and its component line" (approved by National Seed Broad, Ministry of Agriculture in Bangladesh, 2001) and "UPOV Rice Test Guidelines" (sources: TG/16/8; project 3). The qualitative data were transformed to binary form as described by Sneath and Sokal (1973). The presence and absence of the different variants scored as 1 and 0, respectively were calculated by computer using Power Marker version 3.25 software (Liu and Muse, 2005). The qualitative binary data were subjected to cluster analysis using the computer package NTSYS-pc version 2.2 (Rohlf, 2002). A similarity matrix was calculated with the Simqual subprogram using the Dice coefficient, followed by cluster analysis with the SAHN subprogram using the un-weighted pair group method on arithmetic mean (UPGMA) clustering method as implemented in Numerical Taxonomy and Multivariate Analysis System (NTSYS-pc) for portrait the genotypes graphically. The similarity matrix was also used for principal coordinate analysis (PCoA) with the DCenter in NTSYS-pc.

Results and Discussion

Extent of variability of the 21 qualitative characters

The 10 genotypes of duplicate named *Dhaliboro* rice germplasm showed wide range of variability for the qualitative agro-morphological characters under studied. Out of 21 agro-morphological characters, the presence and shape of penultimate leaf ligule showed no variations among the genotypes as because all the genotypes produced split or two-cleft type shape penultimate leaf ligule. Similar result was earlier reported by Hossain (2008) for green leaf color, presence of penultimate leaf ligule and two-cleft ligule shape. But no variation was observed by Nascimento et al. (2011) for light green inter node color and intermediate panicle type and Mahalingam et al. (2012) for presence of leaf auricle, absence of anthocyanin coloration of nodes and well exserted panicle exsertion traits in rice.

Adair et al. (1966) stated that grain size and shape are the first criteria of quality that Breeders consider in developing new varieties for commercial production. In the present study, majority of the genotypes showed no anthocyanin color in leaf sheath (70%), weak, medium and strong intensity of anthocyanin color in basal leaf sheath (each 10%), green leaf blade color (90%), weak surface pubescence of penultimate leaf blade (80%), no anthocyanin color in auricles and collar of penultimate leaf (90%), colorless ligule of penultimate leaf (80%), white color of stigma (90%),

Table 1. List of *Dhaliboro* rice germplasm

Common/ Local name	Code name	Accession number	Place of collection		Date of collection
			Thana	District	
Dhali Boro	DB1	2250	Sylhet sadar	Sylhet	22/05/81
Dhali Boro	DB2	2247	,,	,,	,,
Dhali Boro	DB3	2249	,,	,,	,,
Dholi Boro	DB4	180	Kali kati	Tangail	29-04-74
Dhali Boro	DB5	2245	Sylhet sadar	Sylhet	22/05/81
Dholi Boro	DB6	4396	,,	,,	April, 94
Dhali Boro	DB7	2246	,,	,,	22/05/81
Dhali Boro	DB8	2244	,,	,,	,,
Dhali Boro	DB9	2248	,,	,,	,,
Dhali Boro	DB10	2243	,,	,,	,,
BRRI dhan28	BR28	-	Genebank, BRRI	Gazipur	-
BRRI dhan29	BR29	-	,,	,,	-

erect blade of flag leaf (60%), erect curvature of lateral tiller (100%), no anthocyanin color in nodes (100%), very weak intensity of anthocyanin color in nodes and internodes (100%), yellowish to straw anthocyanin color of lemma and palea (below apex area) (100%), strong intensity of anthocyanin color in lemma and palea (100%), purple apex color of apiculus (70%), awnless (70%), distribution of awns at tip only (20%), yellowish white to straw and brown color awns (each 50%) and late and slow type of leaf senescence (100%), respectively among the 10 genotypes duplicate named *Dhaliboro* rice germplasm. The frequency distributions of 19 qualitative agro-morphological characters are presented in Figure 1. However, Nascimento et al. (2011) found white color of stigma and presence of the glumella pubescence as dominant types in 146 accessions of upland rice. Parikh et al. (2012) also observed majority of the genotypes to possess green basal leaf sheath color (84.5%), green leaf blade color (86.8%), green tip color (57.8%), green leaf margin color (57.8%), green collar color (97.3%), white ligule color (94.7%), light green auricle color (97.3%), semi erect plant habit (44.7%), white apiculus color (53.9%), white stigma color (94.7%), awnless (72.3%) and white sterile glume color (59.2%) in 71 aromatic rice germplasm.

Detailed frequency distributions of the 19 qualitative agro-morphological characters

Leaf sheath anthocyanin color

Out of 10 genotypes, the anthocyanin coloration in leaf sheath was present (9) in 30% duplicate named *Dhaliboro* rice germplasm (DB5, DB9 and DB10). The rest of the genotypes (70%) had no anthocyanin coloration (1) in leaf sheath.

Basal leaf sheath anthocyanin color intensity

Out of 10 genotypes, intensity of anthocyanin color in basal leaf sheath of the rest germplasm (each 10%) were weak (3)(DB10), medium (5)(DB9) and strong (7)(DB5), respectively.

Leaf blade color

Maximum number (90%) of the *Dhaliboro* germplasm showed green (2) color leaf blade, while only 10% (DB5) had purple margin (5) leaf blade.

Penultimate leaf blade surface pubescence

Maximum number (80%) of the *Dhaliboro* germplasm had weak (3) surface pubescence on leaf blade and only 20% of the germplasm (DB3 and DB7) had very weak or absent (1) pubescence.

Penultimate leaf auricles and collar anthocyanin color

Anthocyanin coloration of auricles and collar was present (9) only in DB5 (10%) genotype, while rest (90%) of the germplasm had no anthocyanin coloration in auricles and collar (1) of penultimate leaf.

Penultimate leaf ligule color

Around, 80% of duplicate named *Dhaliboro* rice germplasm had colorless (1) ligule in penultimate leaf and 20% of the germplasm (DB5) had green with purple lines (3) color of ligule in the leaf.

Stigma color

Color of stigma of 90% of the germplasm was found light purple (4) and 10% of the germplasm had purple (5) color of stigma (DB5).

Flag leaf blade attitude

Maximum number (60%) of the *Dhaliboro* germplasm had erect ($<30^0$) attitude of blade of the flag leaf. Whereas 40% of the germplasm had semi-erect ($30\text{-}45^0$) type flag leaf blade.

Stem lateral tiller curvature

The main axes of all of the germplasm had erect ($<30^0$) curvature.

Nodes anthocyanin color

All of the germplasm had no anthocyanin coloration in nodes (1).

Nodes anthocyanin color intensity

All of the germplasm had absent or very weak (1) intensity of anthocyanin coloration of node.

Internodes anthocyanin color intensity

All of the germplasm had absent or very weak (1) intensity of anthocyanin colorations of internodes.

Lemma and palea anthocyanin color

The lemma and palea of all the *Dhaliboro* rice germplasm showed yellowish to straw (1) anthocyanin coloration.

Lemma and palea anthocyanin color intensity

The lemma and palea of all the *Dhaliboro* rice germplasm showed strong (7) anthocyanin color intensity (Photo 1).

Apiculus color or tip of lemma color

The 70% of the germplasm showed purple apex (8) and only 30% of the germplasm (DB4, DB8 and DB9) showed yellowish/straw (2) color of apiculus in the germplasm studied.

Awns in spikelet

Out of the 98 germplasm, awns were present (9) only in 22% germplasm but the rest of the genotypes (78%) were awnlesss (1).

Awns distribution

The awn distribution of the *Dhaliboro* rice germplasm showed wide range of variations. Awns were distributed throughout the whole length of panicle (9) in 70% of the germplasm, while distributed on the tip of panicle (1) in 20% (DB4 and

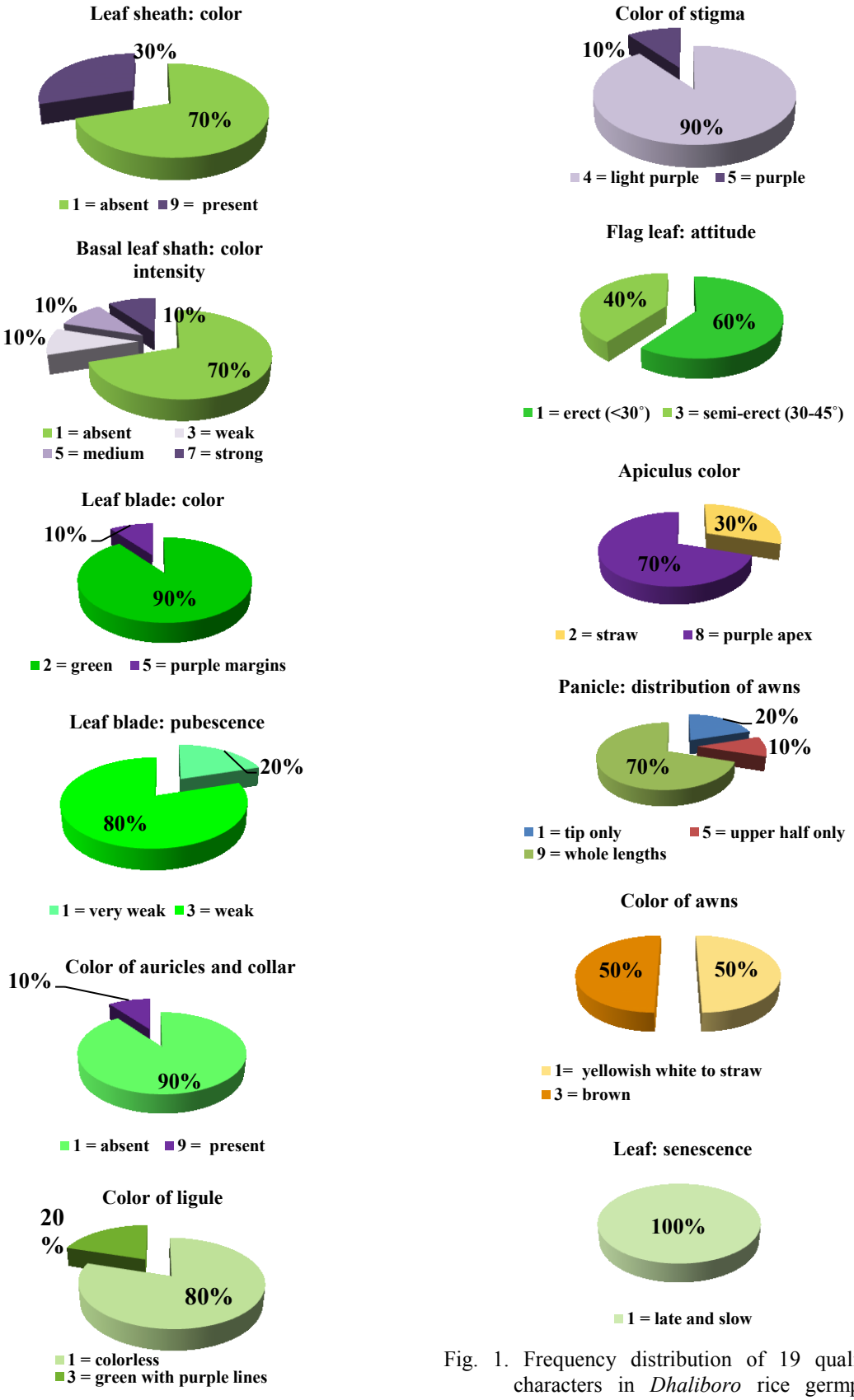

Fig. 1. Frequency distribution of 19 qualitative characters in *Dhaliboro* rice germplasm.

DB8) and upper half of panicle (5) in 10% of the germplasm (DB9).

Awns color

A total of 5 germplasm each showed yellowish white to straw (1) and brown (3) color awns.

Leaf senescence

All of the *Dhaliboro* rice germplasm showed late and slow (1) type of leaf senescence at the time of maturity.

Legend: From left to right row contains DB1 to DB10 genotypes.

Photo 1. Seed grain diversity of *Dhaliboro* rice germplasm.

Cluster analysis of Dhaliboro germplasm for 19 qualitative characters

The dendrogram, constructed by using UPGMA clustering method based on Dice coefficient, distributed the 10 genotypes with two popular BRRI rice varieties namely BRRI dhan28 and BRRI dhan29 into three major clusters along with minor sub-clusters and groups for 19 qualitative agro-morphological traits (Figure 2). Out of three clusters, Cluster III was the major one with maximum genotypes (9), while cluster I consisted with BRRI dhan28 and BRRI dhan29 and cluster II consisted with only DB5, respectively.

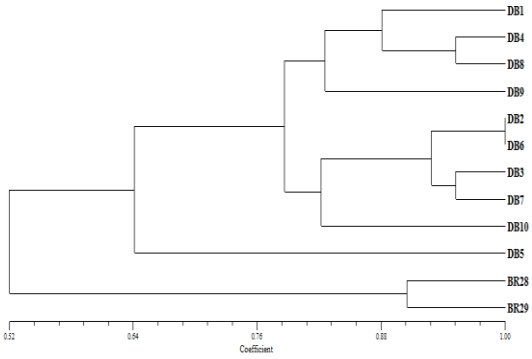

Fig. 2. Dendrogram of duplicate named *Dhaliboro* rice germplasm for 19 qualitative agro-morphological characters.

The first sub-cluster of cluster III consisted with only one genotype namely DB10. The second sub-cluster consisted with four genotypes namely DB7, DB3, DB6 and DB2. The third sub-cluster consisted with four genotypes namely DB9, DB8, DB4 and DB1. Similarly, Rahman et al. (2009) studied 110 rice varieties for evaluating genetic divergence and identified four groups for the qualitative data studied. But, Nascimento et al. (2011) found two major groups by using UPGMA clustering method in 146 accessions of upland rice. But, Hossain (2008) observed 10 clusters by using UPGMA clustering method in 78 aromatic and fine grain land races of rice genotypes.

The genetic distance, ranging from 0.000 to 9.646, also revealed the existence of significant differences among the 10 duplicate named *Dhaliboro* rice land races. The highest distances (9.646) was recorded between genotype DB1 (acc. no. 2250) and DB4 (acc. no. 180). However, the genotypes DB2 (acc. no. 2247) and DB6 (acc. no. 4396) were found duplicate, which indicated that they were 100% similar for all the 21 qualitative agro-morphological characters. Similarly, Bisne and Sarawgi (2008) and Nascimento et al. (2011) found 18 duplicates genotypes by evaluating 32 and 146 rice accessions, respectively and none of these duplicates included accessions with the same genotypes name. But Hossain (2008) found six pairs of duplicate genotypes by evaluating 23 qualitative traits in 78 aromatic and fine grain land races of rice and three pairs of these duplicates (Kalijira-1 & Kalijira-2, Kalijira-8 & Kalijira-10, Kalijira-12 & Kalijira-14) had accessions with the same genotype name. However, Fukuoka et al. (2006) in studies with aromatic rice land races concluded that significant variation may be found among genotypes with the same name.

Conclusion

The traditional *Dhaliboro* germplasm show wide variability and unique qualitative features of rice. The identified unique characters can be utilized for developing new varieties with unique DUS characters. Because it needs to be mention that Intellectual Property Rights is a burning issue for protecting bio-piracy in the worldwide, for which precise identification and distinction of crop variety is a must. However, these processes can also broad the genetic base of modern rice. Finally, molecular characterizations of the studied rice germplasm need to be done for QTL mapping and validating candidate genes responsible for valuable characters.

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