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Distinctness of 110 rice (*Oryza sativa* L.) varieties of Bangladesh through morphological traits

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Abstract

A total of 110 rice varieties of which 108 local (From Bangladesh Rice Research Institute) and two hybrid varieties (From ACI Ltd. Bangladesh) were used to identify the morphological traits during July, 2008 to June, 2009. These varieties represented four types viz. T. Aman (n=92), B. Aman (n=15), Boro (n=2) and Jhum accession (n=1) as described by Bangladesh Rice Research Institute's literature. Though all these materials were varied ecotypically but grown in one (T. Aman) season. Irrespective of groups of all, 90 varieties were appeared distinctly morphologically from others due to seed colour; stigma colour; anthocyanin colouration of leaf sheath, nodes and lemma:palea, presence of awn and nodal root. Among 90 distinct varieties 19 were distinctly different from others by four traits, nine by three traits, 24 by two traits and 38 varieties by only single trait. The rest 20 varieties were distinguished flag leaf: attitude of the leaf blade. This was done to assess the quality traits of distinctness as major concern and was non-influenced by the environment.

Keywords: Rice (*Oryza sativa* L.), Distinctness, Morphological traits

Introduction

Rice, *Oryza sativa* (2n = 24) belongs to the family *Gramineae* and subfamily *Oryzoidae*. Rice is the most important human food crop, providing the staple food for nearly half of the global population, especially in Asia, Africa, and Latin America (FAO, 2004). Due to the great significance of this crop in food security and local culture, Asian farmers have selected a vast number of rice varieties over thousands of years (Jackson, 1995). There is wide genetic variability, leaving a wide scope for future crop improvement (Chakravarthi and Naravaneni, 2006). As the number of rice varieties increases, the ability to distinguish them on the basis of morphological and biochemical traits becomes more difficult, mostly due to genotype-environment interaction. Any developed variety requires distinctness for its identity and protection. Farmers select the best-performing plant from among the varieties bred by breeders, to compensate for environmental variation. Without a good method for maintaining genetic purity of varieties, there is the danger of losing varieties' identity. The advent of plant variety protection lends urgency to the search for solutions to the conservation of plant genetic diversity. Varieties that originated in farmer's fields may be legally protected, as many of those materials have been approved in Bangladesh and elsewhere by the regulating agencies in association with the institutional breeders for protection. This paper on the rice variety identification through distinct qualitative and quantitative traits is part of the morphological and molecular characterization of plant varieties in Bangladesh (Rahman *et al*. 2007; 2008) where descriptors have widely been used.

Materials and Methods

Collection of seed and seedlings

Seedlings 29 days old of 108 local rice varieties were collected from Genetic Resource and Seed Division (GRSD), Bangladesh Rice Research Institute (BRRI) in August 2008. Seeds of varieties ACI 1 and Aalok 932024 were supplied by ACI Ltd. Bangladesh in August 2008. All were planted in the experimental farm on August 4, 2008 for studying morphological traits.

Observation, data collection and record keeping

The experimental plots were visited every day. The approved crop descriptors as given in the Volume 1 of PLANT varieties of Bangladesh (Rahman *et al.,* 2007; 2008) were used for documentation of these varieties.

1. All observations were made on at least 25-30 plants.
2. For the assessment of uniformity of characteristics on the line as a whole, visual assessment was done by a single observation of a group of plants or parts of plants.
3. All observations on the leaf were made on the penultimate leaf.
4. For the assessment of anthocyanin colour characteristics, recommended Breeder's descriptors codes were used.

Measurements

A few qualitative traits such as anthocyanin colouration of leaf sheath, lemma:palea, stigma and node, presence of awn, nodal root and seed shape were mainly utilized for distinctness of rice varieties. Plant height was measured from the base of the plants to the neck of the panicle. The panicle length was measured from the neck to the tip of the panicle of main tillers without awns. Longitudinal dimension was measured as the distance from the base of the lowest sterile lemma to the tip (apiculus) of the lemma or palea, whichever was longer. In the case of awned varieties, length was measured to a point comparable to the tip of the apiculus. Dorsiventral diameter was taken as the distance across the lemma and the palea at the widest point. A few quantitative traits were studied using number of effective tillers, days to 50% flowering and maturity, panicle length, 1000 grain weight and length: width ratio of grains.

Harvesting

The 110 rice varieties were harvested at different times from 27th October, 2008 to 15th January, 2009. This was due to their requirement of different days to reach maturity.

Data analysis

Mean, Standard deviation and Co-efficient of variation were analyzed using a total of six parameters: effective tillers, days to 50% flowering, panicle length (cm), days to maturity, 1000 grains weight and seed length/width ratio.

Results and Discussion

The quantitative results (Table 1) clearly indicate high variation. One of the major traits, the days 50% flowering is considered as the types are Aman and Boro. But one consideration is important that the rice varieties selected over long years but grown under one management conditions in one season will in fact give the expression of that trait as compared to others. This is where the case of distinctness is more important.

In the present study, 92 varieties were T. Aman, 15 B. Aman, 2 Boro, and 1 was classified as Jhum, as per information supplied by BRRI. The important traits for distinctness were anthocyanin colouration of seed, leaf sheath, lemma: palea, stigma, node and seed shape, presence of awn, nodal root. The study includes group-wise distinction as well as overall pooled (110 varieties) distinctness (Table 2).

Distinctness based on qualitative traits of groups

The 110 varieties were identified as belonging to four groups, which were distinctness through 4, 3, 2 or 1 trait (Table 2).

Table 1. Mean values of different Morphological traits of rice varieties

Sl. No.	Variety Name	Ecotype	Effective tillers	Days to 50% Flowering	Panicle length (cm)	Days to maturity	1000 grain weight (g) at 12% moisture	Seed shape (Length/width Ratio)
1	Lal Amon	T. Aman	30.0	100.7	19.7	134.7	23.6	2.7 (MS)
2	Lau Jan	T. Aman	22.3	100.3	19.3	135.3	22.8	3.2 (S)
3	Nara Aswina	T. Aman	20.7	79.3	22.0	114.3	19.2	3.0 (MS)
4	Buna Dhan	T. Aman	13.0	108.7	24.8	146.3	25.8	2.5 (M)
5	Begun Bechi	T. Aman	10.3	105.3	27.2	150.3	10.7	2.4 (M)
6	Bhasha Manik	T. Aman	11.7	110.0	23.2	143.0	26.7	2.9 (MS)
7	Kochu Dhola	T. Aman	10.3	100.7	26.0	138.0	21.1	2.9 (MS)
8	Sunga Wala	T. Aman	15.00	102.7	20.7	138.7	24.1	2.8 (MS)
9	Konek Chul	T. Aman	9.7	111.3	23.0	150.3	19.8	2.1 (B)
10	Horinkhur Panati	T. Aman	15.0	110.7	28.5	145.7	26.3	3.3 (S)
11	Ganjia	T. Aman	12.0	114.7	26.2	149.0	17.6	2.9 (MS)
12	Dudshar	T. Aman	10.0	110.3	25.7	145.3	32.9	2.6 (M)
13	Mathia	T. Aman	18.3	108.0	21.7	142.0	24.2	2.7 (MS)
14	Khirma Pat	T. Aman	18.7	100.0	22.2	146.0	15.1	4.0 (MS)
15	Mukut Sail	T. Aman	17.0	113.3	27.2	145.7	24.9	2.6 (M)
16	Ban Kolom	T. Aman	13.7	110.0	27.7	147.0	28.1	4.3 (S)
17	Safa Har(3)	T. Aman	17.3	109.3	23.3	143.7	25.0	2.7 (MS)
18	Kal Nania	T. Aman	16.7	103.3	21.0	141.3	12.6	2.9 (MS)
19	Shil Pan	B. Aman	16.3	108.7	23.3	143.3	24.1	2.7 (MS)
20	Jabar Sail	T. Aman	13.7	101.3	20.7	141.3	22.5	2.8 (MS)
21	Moisha Mida	T. Aman	14.3	120.0	19.5	151.7	28.5	2.6 (M)
22	Paglakushyari	T. Aman	15.7	110.3	23.0	141.7	11.8	2.4 (M)
23	Pan Kaich	T. Aman	11.7	113.7	21.0	152.3	26.5	2.4 (M)
24	Lal Patjat	T. Aman	11.3	118.0	23.2	154.0	20.5	3.4 (S)
25	Chandda Gotok	T. Aman	8.7	101.3	21.3	146.7	23.4	2.9 (MS)
26	Moisha Mira	T. Aman	8.3	121.3	19.3	152.3	28.9	2.2 (M)
27	Choia Mora	T. Aman	12.7	100.7	27.0	146.0	22.6	3.4 (S)
28	Modhu Maloti	T. Aman	11.0	117.3	22.8	152.0	23.7	3.1 (S)
29	Kali Gochya	T. Aman	9.0	109.0	22.5	151.7	28.2	2.2 (M)
30	Ludi Gochya	T. Aman	8.3	113.0	19.5	155.7	26.9	2.2 (M)
31	Kala Gura	B. Aman	10.3	116.7	22.5	156.3	28.9	2.2 (M)
32	Monura	B. Aman	12.7	117.0	21.3	155.7	25.3	2.6 (MS)
33	Moisa Mira	B. Aman	11.3	115.0	22.3	152.3	32.6	2.6 (MS)
34	Chand Moni(3)	B. Aman	8.3	119.3	25.0	153.3	27.7	2.2 (M)
35	Kamoni Sail	T. Aman	6.0	80.0	21.0	114.3	15.9	3.4 (S)
36	Juna	T. Aman	16.0	105.0	21.2	143.7	23.8	2.6 (M)
37	Kurki	T. Aman	8.7	121.0	22.0	154.3	26.5	2.4 (M)
38	Arai Raj	T. Aman	11.7	99.7	21.5	144.3	22.8	3.0 (MS)
39	Kala Gora	T. Aman	8.0	119.0	21.8	144.3	28.6	2.2 (M) (MS)
40	Mulai	T. Aman	9.0	119.0	29.2	152.3	25.1	2.2 (M)
41	Dharga Sail	T. Aman	12.0	95.3	22.3	140.3	21.5	3.0 (S)
42	Bondyl	T. Aman	7.7	89.7	21.7	113.7	13.8	2.4 (M)
43	Chakkol	T. Aman	12.0	105.3	23.8	153.3	27.7	2.5 (M)
44	Rajamun	T. Aman	11.0	105.3	23.3	151.3	23.8	2.7 (MS)
45	Kanchon Mogi	T. Aman	8.0	120.3	22.8	149.0	21.2	2.9 (MS)
46	Hiruyal	B. Aman	8.3	117.7	23.0	146.7	27.0	2.4 (M)
47	Chapa Mali	B. Aman	10.3	119.7	26.7	152.7	20.1	2.4 (M)
48	Deppol	B. Aman	10.0	112.0	23.7	151.0	27.6	2.4 (M)
49	Pushon	B. Aman	10.0	105.3	23.3	146.3	26.7	2.3 (M)
50	Kali Cochr	B. Aman	10.0	114.3	23.0	144.3	27.2	2.1 (B)
51	Ghori Amon	B. Aman	8.3	114.7	22.5	143.3	28.6	2.7 (MS)
52	Muirol	B. Aman	10.0	120.7	21.0	152.0	21.5	2.7 (MS)
53	Muar Sail	B. Aman	11.7	123.0	22.7	154.7	20.0	2.6 (MS)
54	Jhaw Lota	B. Aman	9.3	119.3	24.3	152.3	25.8	2.3 (M)
55	Bhoban	B. Aman	9.7	117.7	24.3	150.7	28.4	2.4 (M)
56	Ful Badam	Jhum	8.0	77.0	25.0	114.3	23.5	2.6 (M)
57	Galong	T. Aman	6.0	83.0	21.8	114.3	18.8	3.0 (MS)
58	Hasna Chikon	T. Aman	10.3	113.3	24.3	152.3	20.2	2.6 (MS)

Table 1. Contd.

Sl. No.	Variety Name	Ecotype	Effective tillers	Days to 50% Flowering	Panicle length (cm)	Days to maturity	1000 grain weight (g) at 12% moisture	Seed shape (Length/width Ratio)
59	Thakor	T. Aman	12.3	105.3	27.7	143.0	25.9	2.6 (MS)
60	Tembur	T. Aman	9.7	122.7	21.8	155.7	27.0	2.5 (M)
61	Tulsi Mala	T. Aman	11.0	121.0	26.5	155.7	27.7	2.0 (B)
62	Giring	T. Aman	12.7	89.7	25.0	156.3	28.0	2.4 (M)
63	Nag Pechi	T. Aman	12.3	87.3	26.8	156.3	29.3	2.4 (M)
64	Bhua Dhan	T. Aman	11.3	119.0	23.0	156.3	25.2	2.0 (B)
65	Sandik Sail	T. Aman	14.0	122.0	22.7	152.3	20.8	3.3 (S)
66	Jhoria Sail	T. Aman	12.3	105.7	22.8	146.0	18.1	3.1 (S)
67	Halde Medi	T. Aman	11.3	123.0	25.7	156.7	26.6	2.4 (M)
68	Maitya Cheng	T. Aman	13.0	114.7	20.5	143.7	16.5	3.1 (S)
69	Kala Bail	T. Aman	12.3	119.0	24.5	156.0	28.4	2.9 (MS)
70	Murki Balam	T. Aman	12.0	119.0	22.0	154.7	26.8	2.6 (M)
71	Gulchamlaish	T. Aman	12.0	124.0	23.0	155.3	31.4	2.7 (MS)
72	Raj Kumari	T. Aman	10.0	105.0	22.3	156.3	20.1	4.0 (S)
73	Hati Banda	T. Aman	11.3	113.7	22.7	144.0	22.9	2.4 (M)
74	Kui Sail (2)	T. Aman	13.7	124.7	22.5	158.0	21.3	2.2 (M)
75	Chakkol (Muta) Raozan	T. Aman	12.3	125.0	24.2	154.3	26.0	2.7 (MS)
76	Muijuri	T. Aman	15.00	115.00	20.83	145.00	30.62	2.41 (M)
77	Munsi Sail	T. Aman	18.7	97.3	21.3	143.7	19.7	2.9 (MS)
78	Thakur Dhan	T. Aman	12.3	105.7	22.0	142.3	14.8	2.3 (M)
79	Moina Sail	T. Aman	9.3	105.3	22.8	138.0	23.3	2.9 (MS)
80	Butu Balam(2)	T. Aman	11.3	105.7	24.0	142.3	21.0	2.8 (MS)
81	Kali Jira(2)	T. Aman	11.3	102.7	23.8	138.0	10.3	2.4 (M)
82	Jhual Kata	T. Aman	10.7	101.3	24.0	147.7	22.7	3.1 (S)
83	Raj Bhog	T. Aman	7.3	105.3	23.7	146.3	21.3	2.3 (M)
84	Lal Modonga	T. Aman	7.7	113.7	23.3	144.3	19.9	2.3 (M)
85	Surma Sail	T. Aman	16.0	90.7	25.5	146.0	20.7	3.1 (S)
86	Madhu Mala	T. Aman	6.7	100.3	25.0	143.7	16.2	3.5 (S)
87	Dumai Sail	T. Aman	8.8	107.7	17.7	144.7	18.8	2.5 (M)
88	Chadlash	T. Aman	14.0	101.0	25.2	138.0	23.0	2.7 (MS)
89	Jola Bhangh	T. Aman	9.7	108.7	24.3	138.0	19.3	2.7 (MS)
90	Mutonga(2)	T. Aman	10.0	105.3	20.3	144.7	24.4	2.5 (M)
91	Jula Gudi	T. Aman	4.3	108.7	23.7	138.0	25.3	2.6 (MS)
92	Gutok	T. Aman	12.0	108.0	20.7	142.3	28.1	2.3 (M)
93	Pani Torong	T. Aman	12.0	102.7	22.0	142.3	25.2	3.3 (S)
94	Randar	T. Aman	8.0	116.0	21.3	131.0	19.5	3.0 (MS)
95	Bhor Gelam	T. Aman	5.0	121.3	26.3	158.7	27.6	2.6 (MS)
96	Neel Huri	T. Aman	10.0	91.3	23.3	140.7	23.7	3.0 (MS)
97	Jol Kumari	T. Aman	6.7	110.7	28.0	151.3	20.9	2.2 (M)
98	Ful Kari	T. Aman	8.7	97.0	21.5	134.0	21.7	2.4 (M)
99	Biropa	T. Aman	14.3	101.0	21.0	142.3	25.9	2.4 (M)
100	Asham Baba	T. Aman	10.0	84.0	23.0	141.0	24.4	2.6 (M)
101	Dhul Abiz	T. Aman	11.7	114.3	20.7	142.7	28.7	2.4 (M)
102	Porangi	T. Aman	10.7	130.0	22.5	155.3	28.8	2.6 (MS)
103	Tulo Sail	T. Aman	13.7	128.7	26.5	155.3	26.0	2.5 (M)
104	Khoni Dhan	T. Aman	12.3	124.7	22.0	155.3	29.0	2.8 (MS)
105	Choro	T. Aman	11.7	126.0	24.0	156.0	30.1	2.4 (M)
106	Sundar Sail	T. Aman	6.7	97.3	23.1	144.3	21.4	2.6 (M)
107	Bokra	T. Aman	8.3	79.7	22.7	140.7	26.8	2.4 (M)
108	Nagra	T. Aman	21.7	98.3	23.0	140.0	17.8	2.9 (MS)
109	ACI 1	Boro	5.0	92.7	19.7	124.3	23.4	2.4 (M)
110	Aalok-932024 932024	Boro	5.3	95.0	22.3	129.3	18.8	3.1 (S)
Mean	11.5		108.5	23.1	145.5		23.5	2.7
Range	4.3 – 3.0		77.0 -130.0	17.7 - 9.2	113.7 - 158.7		10.3 - 2.9	2.0 - 4.3
St. Dev	3.86		11.56	2.20	9.66		4.66	0.39
CV%	14.77		132.42	4.81	92.52		21.48	0.15

R= Round grains (L:W<1.5); B= Bold grains (L:W=1.5-2.0); M= Medium grains (L:W=2.1-2.5); MS= Medium Slender grains(L:W=2.6-3.0); S= Slender grains(L:W>3.0)

A. T-Aman group: Among 92 T. Aman varieties, one variety, Kal Nania, was distinct from all others on the basis of (i) Anthocyanin colouration of leaf sheath, (ii) Lemma: palea, (iii) Nodes and (iv) Presence of awn. Twelve varieties, Safa Har (3), Kal Nania, Pan Kaich, Modhu Maloti, Kali Gochya, Ludi Gochya, Kala Gora, Bondyl, Kala Bail, Murki Balam, Dumai Sail and Begun Bechi, were distinct from others on the basis of (i) Anthocyanin colouration of Leaf sheath, (ii) lemma:palea, (iii) Nodes and Seed colour.

One variety, Buna Dhan, was identified by anthocyanin colouration of leaf sheath, lemma:palea, presence of awn and seed colour. Based on anthocyanin colouration of lemma: palea, node, nodal root, presence of awn and seed colour two varieties, Tulo Sail and Jola Bhangh were distinct. According to presence of anthocyanin colouration of lemma:palea, node, presence of awn and seed colour one variety, Biropa, was distinct. Two varieties were identified by the presence of anthocyanin colouration of leaf sheath, lemma: palea and nodes, Ful Kari and Mukut Sail. Nag Pechi was distinct due to the presence of anthocyanin colouration of lemma: palea, node, nodal root and presence of seed colour. anthocyanin colouration of lemma: palea, node and presence of seed colour made Pani Torong distinct. Two varieties, Jol Kumari and Hati Banda were distinct by anthocyanin colouration of lemma: palea, presence of awn and seed colour. Based on anthocyanin colouration of lemma: palea, presence of seed colour, seven varieties, Bhasha Manik, Horinkhur Panati, Paglakushyari, Kurki, Kanchon Mogi, Kali Jira (2), and Sundar Sail were distinct. One variety, Ban Kolom, was distinct by presence of anthocyanin colouration of leaf sheath and anthocyanin colouration of lemma:palea. Based on presence of anthocyanin colouration of nodes and presence of awn, Madhu Mala was distinct. Two varieties, Lal Patjat and Galong were distinct by anthocyanin colouration of node and seed colour. Five varieties, Tembur, Choro, Randar, Gutok and Jula Gudi were distinct by anthocyanin colouration of nodes, presence of nodal roots and presence of seed colour. Four varieties, Dudshar, Chakkol (Muta) Raozan, Chadlash, Porangi were distinct by seed colour and awn. Based on presence of nodal roots and seed colour two varieties, Bhua Dhan and Neel Huri were distinct. Four varieties, Lau Jan, Kamoni Sail, Jhual Kata and Mutonga (2) were distinct by anthocyanin colouration of nodes and presence of nodal roots. Muijuri was distinct by anthocyanin colouration of lemma:palea. Based on presence of awn, Sungawala, Konek Chul and Dhul Abiz were distinct. According to presence of seed colour 22 varieties, Mulai, Tulsi Mala, Sandik Sail, Jhoria Sail, Maitya Cheng, Kui Sail (2), Munsi Sail, Moina Sail, Butu Balam (2), Raj Bhog, Khoni Dhan, Bhor Gelam, Asham Baba, Lal Modonga, Lal Amon, Hasna Chikon, Kochu Dhola , Moisha Mida, Choia Mora, Thakor, Dharga Sail, Thakor dhan were distinct (Table 2).

B. B-Aman group: Among 15 B-Aman varieties 13 are distinct. Two varieties, Kali Cochr and Kala Gura, were distinct depending on anthocyanin colouration of leaf sheath, lemma: palea, nodes and seed colour. Based on anthocyanin colouration of leaf sheath, lemma: palea and nodes, Jhaw Lota was distinct. One variety, Monura was distinct based on anthocyanin colouration of lemma:palea, node, presence of seed colour. Based on anthocyanin colouration of lemma:palea, presence of seed colour two varieties, Hiruyal and Chand Moni (3) were distinct. Based on anthocyanin colouration of nodes and presence of nodal roots Muar Sail and Bhoban were distinct. On the basis of seed colour, five varieties, Shil Pan, Pushon, Ghori Amon, Chapa Mali and Moisa Mira were distinct (Table 2).

C. Boro: Among two Boro varieties, ACI 1 was distinct from the other based on presence of anthocyanin colouration of leaf sheath, lemma:palea and nodes (Table 2).

D. Jhum: In this study, only one Jhum variety was included, Ful Badam, which was distinct based on the presence of seed colour (Table 2). In previous studies (Rahman *et al.*, 2006; 2007), 34 and 91 rice varieties were distinguished from each other on anthocyanin colouration of lemma:palea, colour of stigma, anthocyanin colouration of leaf sheath, colour of seed, presence of awn and penultimate leaf; shape of the ligule.

Overall Distinctness based on qualitative traits

Irrespective of groups of rice varieties out of 110, 90 varieties appeared to be distinct morphologically due to seed colour and presence of awn, lemma:palea, anthocyanin colouration of stigma, anthocyanin colouration of leaf sheath, nodes and the presence of nodal root. Among 90 distinct varieties some 19 were distinct by four traits, nine by three traits, 24 by two traits and 38 by a single trait (Table 2). Out of 110 varieties 90 were identified through qualitative traits while 20 were identified by four quantitative traits (Table 2). Those 20 were not distinguishable using the qualitative traits.

Table 2. Distinctness of 90 rice varieties based on qualitative traits

Class	Varieties	Distinct in respect of traits	No. of varieties
Distinction varieties through four traits	Kal Nania	Anthocyanin colouration of leaf sheath, lemma:palea, nodes and presence of awn.	1
	Kali Cochr, Safa Har(3), Kal Nania, Pan Kaich, Modhu Maloti, Kali Gochya, Ludi Gochya, Kala Gura, Kala Gora, Bondyl, Kala Bail, Murki Balam, Dumai Sail, Begun Bechi	Anthocyanin colouration of leaf sheath, lemma:palea, nodes and seed colour.	1
	Buna Dhan	anthocyanin colouration of leaf sheath, lemma: palea, presence of awn and seed colour	1
	Tulo Sail, Jola Bhangh	Anthocyanin colouration of lemma: palea, node, nodal root, presence of awn and seed colour	2
	Biropa	Anthocyanin colouration of lemma: palea, node, presence of awn and seed colour	1
Distinction of varieties through three traits	ACI 1, Jhaw Lota, Ful Kari, Mukut Sail	Anthocyanin colouration of leaf sheath, lemma:palea and nodes.	4
	Nag Pechi	Anthocyanin colouration of lemma: palea, node, nodal root, presence of seed colour	1
	Pani Torong, Monura	Anthocyanin colouration of lemma: palea, node, presence of seed colour	2
	Jol Kumari, Hati Banda	Anthocyanin colouration of lemma: palea, presence of awn and seed colour	2
Distinction of varieties through two traits	Bhasha Manik, Horinkhur Panati, Paglakushyari, Chand Moni (3), Kurki, Kanchon Mogi, Kali Jira (2), Sundar Sail, Hiruyal	Anthocyanin colouration of lemma:palea, presence of seed colour.	9
	Ban Kolom	Anthocyanin colouration of leaf sheath, anthocyanin colouration of lemma:palea	1
	Madhu Mala	Anthocyanin colouration of nodes and presence of awn	1
	Lal Patjat, Galong	Anthocyanin colouration of node, seed colour.	2
	Tembur, Choro, Randar, Gutok, Jula Gudi	Anthocyanin colouration of nodes and presence of nodal roots, presence of seed colour.	5
	Dudshar, Chakkol (Muta) Raozan, Chadlash, Porangi	Presence of seed colour and awn	4
	Bhua Dhan, Neel Huri	Presence of nodal roots, presence of seed colour.	2
Distinction of varieties through single trait	Lau Jan, Kamoni Sail, Jhual Kata, Mutonga (2), Muar Sail, Bhoban	Anthocyanin colouration of nodes and presence of nodal roots	6
	Muijuri	Anthocyanin colouration of lemma:palea.	1
	Sunga Wala, Konek Chul, Dhul Abiz	Presence of awn.	3
	Moisa Mira, Mulai, Tulsi Mala, Sandik Sail, Jhoria Sail, Maitya Cheng, Kui Sail (2), Munsi Sail, Moina Sail, Butu Balam (2), Raj Bhog, Khoni Dhan, Bhor Gelam, Asham Baba, Lal Modonga, Pushon, Ghori Amon, Chapa Mali, Lal Amon, Hasna Chikon, Ful Badam, Kochu Dhola, Shil Pan, Moisha Mida, Choia Mora, Thakor, Dharga Sail, Thakor dhan	Seed colour	28
Total			90

Table 3. Distinctness of 20 varieties, which could not be identified through qualitative traits individually or in combination

Name of variety	Flag leaf: Attitude of the blade (Degree)	Panicle length (cm)	1000 fully developed grains weight (g)	Grain shape (L/W ratio of de-hulled grain)*
Nara Aswina	<46-90°	22.0	19.2	3.0 (MS)
Ganjia	<30°	26.2	17.6	2.9 (MS)
Mathia	>90°	21.7	24.2	2.7 (MS)
Khirma Pat	>90°	22.2	15.1	3.0 (MS)
Jabar Sail	>90°	20.7	22.5	2.8 (MS)
Chandda Gotok	30-45°	21.3	23.4	2.9 (MS)
Juna	46-90°	21.2	23.8	2.6 (MS)
Arai Raj	46-90°	21.5	22.8	3.0 (MS)
Chakkol	>90°	23.8	27.7	2.5 (M)
Rajamun	<30°	23.3	23.8	2.7 (MS)
Deppol	46-90°	23.7	27.6	2.4 (M)
Muirol	46-90°	21.0	21.5	2.7 (MS)
Giring	>90°	25.0	28.0	2.4 (M)
Halde Medi	30-45°	25.7	26.6	2.5 (M)
Gulchamlaish	46-90°	23.0	31.4	2.7 (MS)
Raj Kumari	46-90°	22.3	20.1	4.0 (S)
Surma Sail	30-45°	25.5	20.7	3.1 (S)
Bokra	46-90°	22.7	26.8	2.7 (M)
Nagra	46-90°	23.0	17.8	2.9 (MS)
Aalok 932024	46-90°	22.3	18.8	3.1 (S)

R= Round grains (L:W<1.5); B= Bold grains (L:W=1.5-2.0); M= Medium grains (L:W=2.1-2.5); MS= Medium Slender grains(L:W=2.6-3.0); S= Slender grains(L:W>3.0)

Quantitative traits

Data of 110 varieties related mostly to the quantitative traits (Table 1) indicated a high CV for effective tillers and seed shape (L/W) ratio, and for other traits. These results revealed considerable diversity in the total population. Even when the results were computed for individual groups, the variation was high (Table 4).

Table 4. Mean values of different quantitative traits of rice varieties

Groups		Effective tillers	Days to 50% Flowering	Panicle length (cm)	Days to maturity	1000 grain weight (g) at 12% moisture	Seed Length/width Ratio
(A) T. Aman 92 varieties	Mean	11.7	107.6	23.1	145.1	23.1	2.7
	Range	4.3-30	79.3-130	17.7-29.2	113.7-158.7	10.3-32.9	2.0-4.3
	St. Dev.	4.1	11.5	2.3	9.6	4.8	0.4
	CV%	16.3	131.2	5.3	91.1	22.1	0.2
(B) B. Aman 15 varieties	Mean	10.4	116.1	23.3	150.3	26.1	2.5
	Range	8.3-2.3	105.3-123	21-26.7	143.3-156.3	20.0-32.6	2.1-2.7
	St. Dev.	2.0	4.7	1.4	4.4	3.5	0.2
	CV%	3.9	20.2	1.9	18.2	11.2	0.0
(C) Boro two varieties hybrids	Mean	5.2	93.8	21.0	126.8	21.1	2.8
	Range	5.0 -5.3	92.7-95.0	19.7-22.3	124.3-129.3	18.8-23.4	2.4-3.1
	St. Dev.	0.2	1.7	1.9	3.5	3.3	0.5
	CV%	0.03	1.4	1.8	6.3	5.3	0.1
(D) Jhum one variety	Mean	8	77	25	114.3	23.5	2.6

The coefficient of variation in 92 varieties of T. Aman for effective tillers was 16.3%, while that of the B. Aman group was only 3.9%. It is possible that the B. Aman varieties usually produce fewer effective tillers than T. Aman varieties under normal conditions, and when these were grown under transplant conditions the variation was still low. Even in case of 50% flowering days the T. Aman group showed a very high CV (131.2%) where the other group showed only 20.2%. For days to maturity also a high degree of variation existed in T. Aman group and not in the B. Aman varieties. But for 1000 grain weight the CV for T. Aman was 26.1% while that of B. Aman group was only 11.2%. These indicate that there exists considerable variation only in some of the important characters.

Conclusion

Based on morphological characterization, it has been possible to distinguish each of the 110 varieties. However, some of these traits, particularly the quantitative ones, may not be stable under variable environments. The photographs of these traits and others having importance as marker traits should be recorded for the protection of rice varieties.

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References

Chakravarthi, K.B. and Naravaneni, R. 2006. SSR marker based DNA fingerprinting and diversity study in rice (*Oryza sativa*. L). *African J. Biotec.* 5 (9): 684-688.

FAO, Food and Agriculture Organization of the United Nations. 2004. The State of Food and Agriculture 2003–2004.Agricultural Biotechnology: Meeting the Needs of the Poor (1 June 2005; www.fao.org/docrep/)

Jackson, M.T. 1995. Protecting the heritage of rice biodiversity. *Geo Journal*, 35: 267-274.

Rahman, L., Molla, M.R., Sultana, S., Islam, M.N., Ahmed, N.U., Rahman, M.S. and Nazim-ud-Dowla, M. 2007. PLANT VARIETIES OF BANGLADESH: Morphological and Molecular Characterization. Published by Seed Wing, Ministry of Agriculture, Government of the Peoples' Republic of Bangladesh, Vol. 1, pp.486.

Rahman, L., Molla, M.R., Sultana, S., Islam, M.N., Ahmed, N.U., Rahman, M.S., Nazim-ud-Dowla, M., Shah-E-Alam, M., and M.S. Alam. 2006. Plant Varieties of Bangladesh-Morphological and Molecular characterization for plant variety protection. *Bangladesh J. Agril. Sci.* 33 (2): 215-225.