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Morphological characterization of jute (*Corchorus olitorius* L. and *C. capsularis* L.) varieties and their application for DUS testing

D. Kumar, P. Mahato, S. S. Lakshman and S. Mandi

Division of Crop Improvement, Central Research Institute for Jute and Allied Fibres, Barrackpore 700120

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Abstract

In the present regime of Intellectual Property Rights, the distinctness of a candidate variety from all other varieties is the first basis of the triad of the DUS for granting protection of Plant Breeder's rights. Keeping this in view, twenty seven varieties of jute (*Corchorus olitorius* L. and *C. capsularis* L.) including 20 released or notified and 7 varieties of common knowledge were characterized for three years using 16 qualitative morphological characteristics to establish distinctness among the varieties. Among them, 10 characters in *C. capsularis* were found mono-morphic and 6 characters were dimorphic where as in *C. olitorius* 2 characters were mono-morphic, 8 characters were dimorphic and 6 characters were polymorphic between varieties indicating their potential for varietal characterization. No intra-varietal variation was observed for any of the characteristics. The expression of each character in all varieties was similar for three consecutive years confirming the stability of varieties. No character could identify all the varieties individually. On the basis of 16 qualitative characteristics identity and distinctness of few varieties *viz.*, Bidhan rupali, JRO 878, Chinsurah green, JRO 66, JRO 7835 and JRO 36E in *olitorius* and Padma and D-154 in *capsularis* could be established individually and remaining varieties could be classified into two or more groups. The candidate variety, Bidhan rupali, was distinct from all other *olitorius* varieties and the candidate variety, JRC 321, was similar to UPC-94. Hence, to meet DUS criteria as identification of jute varieties, some of the distinct morphological characters in coalition with biochemical or molecular characters may be necessary.

Key words : Jute, morphological characteristics, varietal characterization, DUS testing

Introduction

Twenty jute varieties have been released in India since 1966 and their number is expected to increase in future. Jute varieties attain acceptance when the farmers get genetically pure seeds of high standards as well as for their fibre yield performance. For this purpose, each jute variety should be properly defined with suitable descriptors so as to maintain its identity during seed production through field inspection and certification. Apart from this, characterization of jute varieties is also required for their protection under Plant Variety Protection (PVP) legislation, because varietal testing for Distinctness, Uniformity and Stability (DUS) is the basis for grant of protection of new plant varieties under the Protection of Plant Varieties and Farmers' Rights Act, 2001 [1]. The Act has the provision to compare the candidate variety with the varieties of common knowledge on a set of relevant characteristics prescribed in the Draft National Test Guidelines for DUS testing of jute [2] and commonly accepted for this purpose at the time of filling of application.

Since jute has been domesticated only around two hundred years ago and many mutants have not yet been accumulated in jute population due to lack of human selection pressure for longer time [3], qualitative morphological characters of jute are mostly monomorphic and few are dimorphic and polymorphic. In India, while certain diagnostic features for released or notified jute varieties are known and used in seed certification [4], the descriptors by and large are incomplete. The varieties have not so far been extensively described for various heritable morphological traits to enable the identification of these varieties and for unambiguous ascertainment of distinctness. Thus, the present study was undertaken to characterize twenty released or notified and seven varieties of common knowledge of both the species of jute on the basis of qualitative morphological characters and to establish distinctness of the candidate variety from all other varieties and also among extant varieties of both species separately.

Materials and methods

A total of 20 varieties of both species of jute released or notified in India and 7 varieties of common knowledge were studied for 16 morphological characters *viz.*, seedling premature flowering resistance, leaf lamina colour, leaf vein colour, stem colour, stipule colour,

branching habit, leaf angle, leaf shape, days to 50% flowering, days to harvestable maturity, pigmentation of calyx, plant height, fruit pigmentation, pod dehiscence, 1000 seed weight and colour of seed coat, with different character states as per the Draft National Test Guidelines for testing Distinctness, Uniformity and Stability (DUS) for jute [2]. Seven of the varieties were developed by pureline selection (JRO 632, JRO 620, Chinsurah green, JRO 36E, JRC 212, JRC 321 and D 154), fourteen by hybridization (JRO 3690, TJ 40, JRO 66, JRO 524, JRO 7835, JRO 878, JRO 8432, JRO 128, Padma, JRC 4444, UPC 94, JRC 698, Bidhan Pat 2 and Bidhan Pat 3), four by mutation breeding (KOM 62, Bidhan rupali, JRC 7447 and Bidhan Pat 1) and two varieties (Sudan green and Tanganyika 1) were direct introductions (Table 1).

Nucleus or breeder seed was used for the study in the first year and later seed grown from the original seed was used for further study. The experiment was conducted during rainy season of 2003-04, 2004-05 and 2005-06 at two designated DUS testing centers of jute *viz.*, CRIJAF, Barrackpore and Central Seed Research Station for Jute and Allied Fibres, Bud Bud, Burdwan in randomized block design with 3 replications. Each replication consisted of four rows of 5 m length with 40 × 5 cm spacing. During 2005-06 DUS testing trial run was conducted with a candidate variety *viz.*, Bidhan rupali, in *C. olitorius* and JRC 321 in *C. capsularis*.

The observations were recorded on 10 plants in each replication at specified stages of crop growth period when the characters under study had full expression. Premature flowering resistance was observed after 35 days of sowing. Four characters *viz.*, leaf lamina colour, leaf vein colour, stem colour and stipule colour were observed at full foliage stage i.e. after 60 days of sowing. Four characters *viz.*, plant branching habit, leaf angle, leaf shape and plant height were observed at pre bud stage. Pigmentation of calyx was observed at the time of appearance of flower buds. The character, time of harvest maturity, was noted at the time of early pod stage. Fruit pigmentation and pod dehiscence were observed at early fruiting (before pod browning) and near maturity stage

Table 1. Passport information on the jute varieties

Name	Pedigree	Year of release	Centre
***C. olitorius*: Notified varieties**			
JRO 632	Pureline selection from an indigenous germplasm	1954	CRIJAF, Barrackpore
JRO 3690	Selection from Tobacco leaf × long inter-node	1985	CRIJAF, Barrackpore
KOM 62	JRO 878 treated with 40 Kr gamma ray	1993	JRS, OUAT, Kendrapara
TJ 40	Selection from a cross between mutants of JRO 632	1983	BARC, Trombay
JRO 66	Selection from a multiple cross	1998	CRIJAF, Barrackpore
JRO 524	Selection from Sudan green × JRO 632	1977	CRIJAF, Barrackpore
JRO 7835	Selection from JRO 632 × Sudan green	1971	CRIJAF, Barrackpore
JRO 878	Selection from JRO 620 × Sudan green	1967	CRIJAF, Barrackpore
JRO 8432	Selection from IC 15901 × Tanganyika-1	1999	CRIJAF, Barrackpore
JRO 128	Selection from TJ-6 × Tanganyika-1	2002	CRIJAF, Barrackpore
***C. olitorius*: Varieties of common knowledge**			
JRO 620	Selection from local type		CRIJAF, Barrackpore
Chinsurah green	Selection from a local strain in Chinsurah	1915	CRIJAF, Barrackpore
Sudan green	Introduction from Sudan,Africa		CRIJAF, Barrackpore
Tanganyika 1	Introduction from Tanganyika		CRIJAF, Barrackpore
Bidhan rupali	X-ray induced mutant of JRO 632		BCKV, Kalyani
JRO 36E	Selection from Tanganyika-1		CRIJAF, Barrackpore
***C. capsularis*: Notified varieties**			
JRC 212	Selection from an indigenous germplasm	1954	CRIJAF, Barrackpore
JRC 7447	X-ray derivative of JRC-212	1971	CRIJAF, Barrackpore
JRC 321	Selection from an indigenous germplasm "Hewti"	1954	CRIJAF, Barrackpore
Padma	Selection from JRC-6165 × JRC-412	1983	CRIJAF, Barrackpore
JRC 4444	Selection from JRC 212 × D 154	1978	CRIJAF, Barrackpore
UPC 94	Selection from JRC-321 × JRC-212	1983	JRS, NDUAT, Baharaich
JRC 698	Selection from a multiple cross	1999	CRIJAF, Barrackpore
Bidhan Pat 1	Gamma ray derivative of D 154	2001	BCKV, Kalyani
Bidhan Pat 2	Selection from D 154 × D 18 (mutant)	2001	BCKV, Kalyani
Bidhan Pat 3	Selection from D 154 × D 18	2001	BCKV, Kalyani
***C. capsularis*: Varieties of common knowledge**			
D 154	Selection from Kakya Bombai	1919	JRL, Dhaka

respectively and lastly seed characters like seed size and seed colour were observed at harvest maturity stage. All the observations were recorded in all the 3 years. Attempts had been made through flow chart to establish distinctness of the candidate variety from all other varieties and also among extant varieties of both species separately.

Results and discussion

The accurate description and identification of jute varieties are not only pre-requisites for production of pure foundation and certified seeds but are also crucial for DUS testing. The identity of a jute variety is established by using a set of morphological characteristics. These characteristics are also useful to establish distinctness, uniformity and stability of the new variety, based on which the variety is given protection. In the present study, sixteen morphological characteristics listed in the Draft National Test Guidelines of Jute [2] for Distinctness, Uniformity and Stability (DUS) were explored for varietal description of jute that were most important from the seed production point of view and genetic purity testing. Out of sixteen qualitative characteristics studied, in *olitorius* 6 characters (Table 2) were found to be polymorphic (*viz.*, leaf vein colour, stem colour, stipule colour, plant height, fruit pigmentation and seed colour), 8 characters were dimorphic (*viz.*, seedling premature flowering resistance, leaf lamina colour, leaf shape, time of flowering, pigmentation of calyx, time of harvest maturity, pod dehiscence and seed size) and 2 characters were monomorphic (*viz.*, plant branching habit and leaf angle) while in *capsularis* 10 characters were monomorphic and 6 characters were dimorphic (*viz.*, stem colour, time of flowering, pigmentation of calyx, plant height, time of harvest maturity and fruit pigmentation). The polymorphic characters among jute varieties indicated their potential for varietal characterization.

The seed morphological characters such as seed size and seed colour were easy to detect and could classify jute varieties into few broad categories in *olitorius* but seed size and seed colour (*viz.*, large and chocolate brown) were similar for all the varieties in *capsularis.* Both seed size and seed colour were stable and uniform over three years in all the varieties of both species studied. Seed size categorized the *olitorius* varieties into two groups *viz.*, small and medium with twelve and four varieties in each group (Table 2). In *olitorius* three categories of varieties were formed based on seed colour *viz.*, steel grey, black and green comprising seven, five and four varieties respectively (Table 2).

Seedling premature flowering resistance character in *olitorius* had been found to be very useful for the identification of tossa jute varieties. Based on this character *olitorius* varieties were grouped into two categories *viz.*, present and absent comprising eight varieties in each category. In *capsularis* all the varieties were resistant to premature flowering. Each polymorphic plant characteristic grouped the jute varieties into different categories based on the number of states of expressions (Table 2). Stem colour was scored for pale green, green, red, purple or coppery red and not for different intensities of colour pigmentation, which is liable to vary depending on the skill of the observer and the effect of the environment within varieties as well as between varieties. Expression of each characteristic was found stable in all the three years in the respective varieties, thus confirming the consistency and stability. The stability of qualitative characteristics can be attributed to a low genotype environment interaction in the expression. This is due to the fact that most of the qualitative characteristics are controlled by single or two genes with simple dominant or recessive gene. Apart from this, during the development of varieties, jute breeders purposefully emphasize on the stability and uniformity of the qualitative characteristics. Though some jute varieties were released long back (Table 1), they were stable with regard to qualitative characteristics. Using sixteen qualitative morphological characteristics, identity of few jute varieties could be established individually and could group remaining jute varieties into two or more groups.

Observations on plant height (short, medium, tall), leaf angle (semi-erect), days to 50% flowering (medium, late) and time of harvest maturity (medium, late) were recorded and though quantitative in nature these could be grouped into distinct classes and could be useful for varietal identification and genetic purity testing. It was very interesting to note that there was no variation in the observations of three years for these characters, thus approved to be more dependable (stable) for varietal characterization of jute.

As already mentioned sixteen *olitorius* varieties could be grouped into two distinct classes in respect to premature flowering resistance (Table 2). Among ten notified *olitorius* varieties, resistance was present in 5 varieties and was absent in 5 varieties (Fig. 1). Out of 5 *olitorius* premature flowering resistant varieties 4 (JRO 524, JRO 7835, JRO 8432 and JRO 128) had green stem colour and only one, JRO 878, had red stem colour. JRO 524 was moderately resistant to yellow mite and JRO 7835 had an unique character root primordia modified as spine like out growth at the base of the stem that was not found in any other *olitorius* variety. These two characters *viz.*, yellow mite resistance and presence of root primordia, have not been listed either in minimal descriptor of jute [5] or in the Draft National Test Guidelines for DUS testing

of jute [2]. The red pigmented premature flowering resistant variety JRO 878 had finest fibre (2.60 tex). Out of 5 notified premature flowering susceptible *olitorius* varieties 4 had green stem colour and only one variety, KOM 62, had red stem colour. Out of 4 green stem colour varieties JRO 66 had non-dehiscent pod.

Among 6 *olitorius* varieties of common knowledge 3 varieties *viz.*, Sudan green, Tanganyika 1 and JRO 36E were premature flowering resistant with green stem colour and the rest were susceptible to early flowering. Among the three susceptible varieties Chinsurah green had green and JRO 620 had red stem but Bidhan rupali had pale green stem colour and was distinct from all other *olitorius* varieties. JRO 620 had finest fibre (2.78 tex). Distictness of *olitorius* varieties *viz.*, Bidhan rupali, JRO 878, Chinsurah green, JRO 66, JRO 7835 and JRO 36E could be established individually.

Though polymorphic characters were less among *capsularis* varieties, 3 varieties *viz.*, JRC 321, Padma and UPC 94 had coppery red stem and fruit, one variety, D 154 had green stem with red coloured petiole and all others had green stem (Fig. 2). JRC 321 and UPC 94 were medium flowering type and had red

Table 2. Characterization of jute varieties released or notified and varieties of common knolwledge based on morphological characters

Genotypes	Premature flowering resistance	Leaf lamina colour	Leaf vein colour	Stem colour	Stipule colour	Branching habit	Leaf angle	Leaf shape	Time of 50% flowering	Pigmentation of calyx	Plant height	Time of harvest maturity	Fruit pigmentation	Pod dehiscence	1000 seed weight	Seed colour
***C. olitorius*: Notified varieties**																
JRO 632 (Baisakhi Tossa)	1	2	2	2	2	3	3	2	7	2	7	7	2	2	5	2
JRO 3690 (Sabitri)	1	2	2	2	2	3	3	2	7	2	7	7	2	2	3	2
KOM 62 (Rebati)	1	2	2	3	3	3	3	2	7	2	5	7	3	2	3	2
TJ 40 (Mahadev)	1	2	2	2	2	3	3	2	7	2	7	7	2	2	3	5
JRO 66 (Golden Jubilee)	1	2	2	2	2	3	3	2	7	2	7	7	2	1	3	2
JRO 524 (Navin)	2	2	2	2	2	3	3	2	7	2	5	7	2	1	5	4
JRO 7835 (Basudev)	2	2	2	2	2	3	3	2	7	2	7	7	2	1	3	4
JRO 878 (Chaitali Tossa)	2	2	3	3	3	3	3	2	7	2	7	7	3	1	3	4
JRO 8432 (Shakti Tossa)	2	2	2	2	2	3	3	2	7	2	5	7	2	1	3	4
JRO 128 (Surya)	2	2	2	2	2	3	3	2	7	2	5	7	2	1	5	4
***C. olitorius*: Varieties of common knowledge**																
JRO 620	1	2	2	4	3	3	3	2	7	2	5	7	3	1	3	2
Chinsurah green	1	2	2	2	2	3	3	2	5	2	3	5	2	2	3	5
Sudan green	2	2	2	2	2	3	3	2	7	2	3	7	2	1	3	5
Tanganyika 1	2	2	2	2	2	3	3	2	7	2	3	7	2	1	3	5
Bidhan rupali	1	1	1	1	1	3	3	2	7	1	5	7	1	2	3	2
JRO 36E	2	2	2	2	2	3	3	3	7	2	7	7	2	1	5	2
***C. capsularis*: Notified varieties**																
JRC 212 (Sabuj sona)	2	2	2	2	2	5	3	2	5	2	5	5	2	1	7	3
JRC 7447 (Shyamali)	2	2	2	2	2	5	3	2	7	2	5	7	2	1	7	3
JRC 321 (Sonali)	2	2	2	5	2	5	3	2	5	3	5	5	3	1	7	3
Padma	2	2	2	5	2	5	3	2	7	3	5	7	3	1	7	3
JRC 4444 (Baldev)	2	2	2	2	2	5	3	2	7	2	5	7	2	1	7	3
UPC 94 (Reshma)	2	2	2	5	2	5	3	2	5	2	5	5	3	1	7	3
JRC 698 (Shrabanti white)	2	2	2	2	2	5	3	2	7	2	5	7	2	1	7	3
Bidhan Pat-1	2	2	2	2	2	5	3	2	7	2	5	7	2	1	7	3
Bidhan Pat-2	2	2	2	2	2	5	3	2	5	2	5	7	2	1	7	3
Bidhan Pat-3	2	2	2	2	2	5	3	2	7	2	5	7	2	1	7	3
***C. capsularis*: Varieties of common knowledge**																
D 154	2	2	2	2	2	5	3	2	7	3	3	7	2	1	7	3
*States of characteristics according to National Test Guidelines of Jute	1.Absent* 2.Present	1.Pale green 2.Green	1.Pale green 2.Green 3. Red	1.Pale green 2.Green 3. Red 4.Purple 5.Coppery red	1.Pale green 2.Green 3. Red	3.Weak 5.Medium	3.Semi erect	2.Ovate lanceolate 3.Lanceolate	5.Medium 7.Late	1.Pale green 2.Green 3. Red	3.Short 5.Medium 7. Tall	5.Medium 7.Late	1.Pale green 2.Green 3. Red	1. Absent 2.Present	3.Small 5.Medium 7.Large	2.Steel grey 3.Chocolate brown 4.Black 5.Green

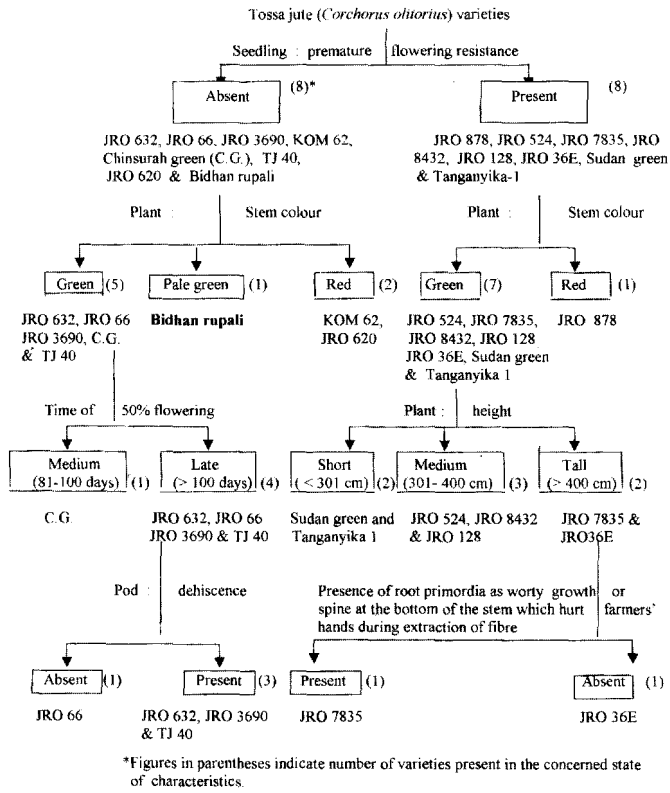

Fig. 1. Result of DUS testing of jute with candidate variety, Bidhan rupali

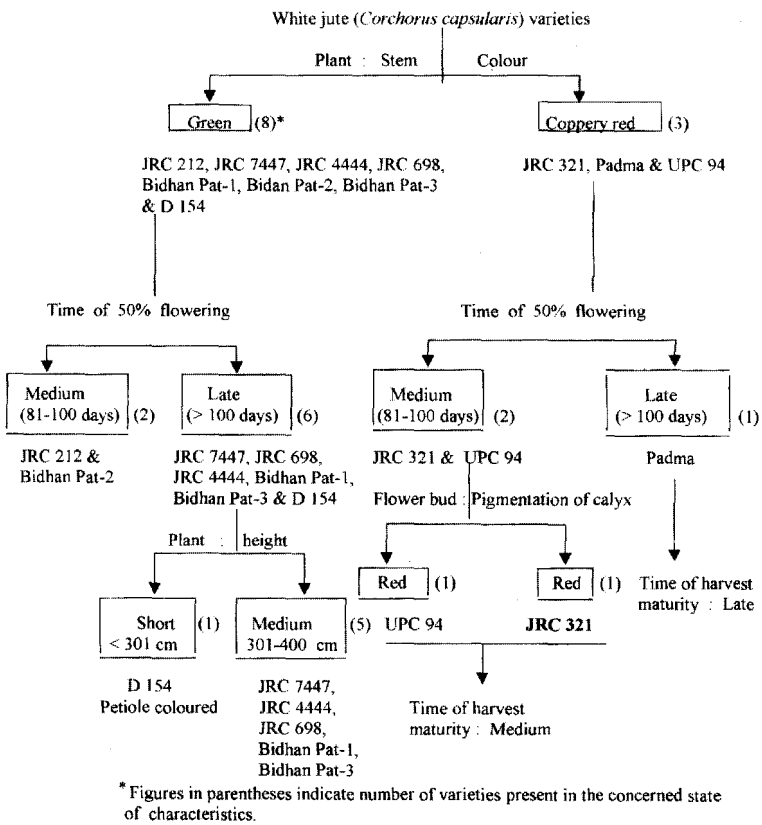

Fig. 2. Result of DUS testing of jute with candidate variety, JRC 321

pigmented calyx whereas Padma was late flowering and late maturity type. D-154 and Padma were distinct from all other *capsularis* varieties but JRC 321 was similar to UPC 94.

It may be concluded that the qualitative characteristics of jute were stable over years and less cumbersome to record. Hence, these are not only suitable for varietal characterization but also reliable and reproducible for assessing the genetic purity of varieties and to establish their identity. But morphological traits alone may not suffice for the DUS criteria. Hence, collaboration through biochemical and molecular characters need to be explored for the delineation of jute varieties for varietal protection.

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