Indian Res. J. Genet. & Biotech 7(1) : 109 – 113 (2015)

Establishment of distinctiveness of jute (*Corchorus olitorius* L. And *C. Capsularis* L.) varieties

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(Received: November 2014; Revised: December 2015; Accepted: January 2015)

Abstract

An experiment was conducted in two phases to characterize jute (*Corchorus olitorius* and *C. capsularis*) varieties, including released/notified and of common knowledge, through distinctness, uniformity and stability (DUS) testing trials for two consecutive years on the basis of heritable morphological traits to enable identification of these varieties and for unambiguous ascertainment of distinctness among extant varieties of both species separately. In first phase twenty seven varieties of both the species were characterized using 16 morphological characteristics prescribed in the Draft National Test Guidelines for testing DUS for jute to establish distinctiveness among the varieties. Out of 16 morphological characters in *C. capsularis* 10 characters were found mono-morphic and 6 characters were di-morphic, whereas in C. *olitorius* 2 characters were found mono-morphic, 8 characters were di-morphic and 6 characters were poly-morphic between varieties. In second phase a total of 25 varieties of both species of jute were studied for 17 morphological characters as per the revised Official DUS Test Guidelines for jute. Out of 17 traits, 8 in *C. capsularis* were found mono-morphic, 7 traits were di-morphic and only 2 traits were poly-morphic, while in *C. olitorius* 8 traits were di-morphic and 9 traits were polymorphic among varieties. Therefore, the revised set of 17 characters included in the Official DUS Test Guidelines of Jute is found to be more effective in distinguishing the jute varieties.

Key words: Distinctiveness, uniformity, stability, morphological characterization and Descriptors.

Introduction

In India twenty-five jute varieties have been released 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 Distinctiveness, 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 (PPV & FR Act 2001). The Act has the provision to compare the novel candidate variety with the varieties of common knowledge on a set of relevant characteristics prescribed in the Revised Official DUS Test Guidelines of Jute (PPV&FR Authority 2008) and commonly accepted for this purpose at the time of filling of application.

Since jute has been domesticated only around two hundred years ago with less mutant accumulation due to lack of human selection pressure (Mukherjee and Kumar 2002) qualitative morphological characters of jute are mostly monomorphic. In India, while certain diagnostic features for released or notified jute varieties are known and used in seed certification (Kumar *et al*., 2005) 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 distinctiveness. Thus, the present study was undertaken to characterize the jute varieties of both the species in two phases on the basis of morphological characters as prescribed in the Draft DUS Test Guidelines of Jute (Kumar and Mahapatra, 2004) in the first phase and as prescribed in the Revised Official DUS Test Guidelines of Jute

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Published by the Indian Society of Genetics, Biotechnology Research and Development
Biotech Bhawan 5 E Nikhil Estate, DPS Road, Shastripuram, Agra 282007
Online management by www.isgbrd.co.in

(PPV&FRA, 2008) in the second phase and to compare the efficiency of the two DUS Test Guidelines for establishing distinctiveness among extant varieties of both species separately.

Materials and Metyhods

A total of 25 varieties of both species (*Corchorus olitorius* L. and *C. capsularis* L.) of jute released or notified in India and 7 varieties of common knowledge were studied for 17 morphological characters. These characters are: premature flowering resistance, leaf lamina colour, leaf vein colour, leaf petiole colour, stipule colour, stem colour, leaf shape, plant height, fibre fineness, fibre strength, pigmentation of calyx, time of 50% flowering, basal stem root primordia, pod pigmentation, pod dehiscence, seed size and seed colour with different character states as per the Revised Official DUS Test Guidelines of Jute (PPV&FR Authority, 2008).

Nine of the varieties were developed by pureline selection (JRO-632, JRO-620, Chinsurah Green, JRO-36E, JRO-2345, JRC-212, JRC-321, KTC-1 and D-154), 16 by hybridization (JRO-3690, TJ-40, JRO-66, JRO-524, JRO-7835, JRO-878, JRO-8432, JRO-128, S-19, Padma, JRC-4444, UPC-94, JRC-698, Bidhan Pat-2, Bidhan Pat-3 and JRC-80), 5 by mutation breeding (KOM-62, Bidhan Rupali, JRC-7447, Bidhan Pat-1 and KC-1), and 2 varieties (Sudan Green and Tanganyika-1) were direct introductions (Table 1).

Nucleus or breeder seed of each variety derived from the germplasm pool of Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal, India was taken for the study. The DUS Testing trials were conducted for two years during rainy season of 2006-07 and 2007-08 at two designated DUS testing centers of jute, viz. Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, West Bengal, India (latitude and longitude of 22°45′N and 88°26′E, respectively) and Central Seed Research Station for Jute and Allied Fibres (CSRSJAF), Budbud, Burdwan, West Bengal, India (latitude and longitude of 22°30′N and 88°26′E, respectively) in randomized complete block design with three replications. Each replication consisted of four rows of 6 m length with 40 cm row to row and 7 cm plant to plant spacing.

The observations were recorded on 10 randomly selected 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. Number of off types was recorded in each plot of each variety at both the locations in each year. Five characters (leaf lamina colour, leaf vein colour, leaf petiole colour, stipule colour and stem colour) were observed at fully expanded foliage after 60 days of sowing. Two characters (leaf shape and plant height) were observed at pre-bud stage before development of first flower. Two fibre quality characters (fibre fineness and fibre strength) were observed after harvesting, retting and drying of fibre. Fibre fineness is the diameter of the filament expressed in tex, while fibre strength (unit is g/tex) is calculated as the breaking load of the fibre sample divided by the linear density of the unstrained fibre which is referred to as its tenacity. This trait was measured from the replicated samples by Airflow method (Singh and Bandopadhyay, 1968) which is broadly followed everywhere for assessing fibre fineness in natural fibres. On the contrary, fibre strength was determined by fibre bundle strength tester (NIRJAFT, Kolkata) which gives an average value of fibre strength of different fibre samples. The detail procedure for measurement of these two characters has been discussed in the Revised Official DUS Test Guidelines of Jute (PPV&FR Authority, 2008). Pigmentation of calyx was observed at the time of appearance of flower buds. The character time of 50% flowering was noted when 50% of the plants had at least one open flower. This trait envisages the resistance to premature flowering. If a jute variety sown before middle of April does not flower prematurely in seedling stage and flowers at least after 100 days, the variety is known as premature flowering resistant variety. The presence or absence of basal stem root primordia was noted at half-way stage of flower opening. Pod pigmentation and pod dehiscence were observed at early fruiting stage and near pod maturity, respectively. Lastly, seed characters like seed size and seed colour (visual observation) were observed at harvest. Attempts had been made through flow chart (Figs. 1 and 2) to establish distinctness of the dummy candidate variety from all other varieties and also among extant varieties of both species separately.

Results and Discussion

In the study of first phase, sixteen morphological characteristics listed in the Draft National Test Guidelines of Jute (Kumar and Mahapatra, 2004) 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* 5 characters (Table 2) were found to be polymorphic (viz. leaf vein colour, stem colour, stipule colour, plant height and fruit pigmentation), 9 characters were found to be dimorphic (viz. seedling premature flowering resistance, leaf lamina colour, leaf shape, time of flowering,

pigmentation of calyx, time of harvest maturity, pod dehiscence, seed size and seed colour) and 2 characters were found monomorphic (viz. plant branching habit and leaf angle) while in *capsularis* 10 characters were found to be monomorphic and 6 characters were found dimorphic (viz. stem colour, time of flowering, pigmentation of calyx, plant height, time of harvest maturity and fruit pigmentation). The polymorphic characters in 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* two categories of varieties were formed based on seed colour viz. steel grey and black comprising three and thirteen 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 comprising six varieties and absent comprising ten varieties. 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. 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-errect), 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 (Mahapatra 2000) or in the Draft National Test Guidelines for DUS testing of jute (Kumar and Mahapatra 2004). The red pigmented premature flowering resistant variety, JRO 878 had finest fibre (2.60 tex). Out of 5 premature flowering susceptible *olitorius* varieties 5 had green stem colour but JRO 66 had non-dehiscent pod and only one variety, KOM 62, had red stem colour.

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) and was the donor for JRO 878 for fine fibre as JRO 620 was one of its parents.

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. JRC 321 and UPC 94 were medium flowering type (Fig. 2).

Therefore, it was found 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 are also reliable and reproducible for assessing the genetic purity of varieties and to establish their identity. On the basis of 16 qualitative characteristics identity of few varieties could be established individually and remaining varieties could be classified into two or more

groups. The dummy candidate variety, Bidhan Rupali, was distinct from all other *olitorius* varieties but the dummy candidate variety, JRC 321, was similar to UPC 94.

In the study of second phase, seventeen morphological characteristics listed in the revised Official DUS Test Guidelines for jute (PPV&FRA, 2008) for Distinctiveness, Uniformity and Stability (DUS) were explored for varietal description of jute. Out of seventeen morphological characteristics studied, in *C. capsularis* eight traits (Table 3) were found monomorphic (viz. premature flowering resistance, leaf lamina colour, leaf vein colour, stipule colour, leaf shape, basal stem root primordia, pod dehiscence and seed colour), eight traits (leaf petiole colour, stem colour, plant height, fibre fineness, pigmentation of calyx, time of 50% flowering, pod pigmentation and seed size) were dimorphic and only one trait (fibre strength) was polymorphic, whereas in *C. olitorius* one trait (time of 50% flowering) was monomorphic, eight traits (premature flowering resistance, leaf lamina colour, leaf shape, fibre strength, pigmentation of calyx, basal stem root primordial, pod dehiscence and seed size) were dimorphic and 8 traits (leaf vein colour, leaf petiole colour, stipule colour, stem colour, plant height, fibre fineness, pod pigmentation and seed colour) were polymorphic among varieties indicating their potential for varietal characterization.

Eighteen *olitorius* varieties could be grouped into two distinct classes in respect to premature flowering resistance (Table 3). Resistance was present in 10 varieties and was absent in 8 varieties (Fig. 3). Out of 10 *olitorius* premature flowering resistant varieties 7 (JRO 524, JRO 7835, JRO 8432, JRO 128, JRO 36E, Sudan Green and Tanganyika 1) had green stem colour and only two, JRO 878 and S-19, had red stem colour. The seed coat colour of the red pigmented premature flowering resistant variety S–19 was steel grey and that of JRO 878 was black. Out of seven premature flowering resistant green stem coloured varieties two (Sudan green and Tanganyika -1) were short, four (JRO 524, JRO 8432, JRO 128 and JRO 2345) were medium and two (JRO 7835 and JRO 36 E) were tall with regard to plant height. Sudan Green was similar to Tanganyika 1. Seed coat colour of JRO 2345 was green and that of JRO 524, JRO 8432 and JRO 128 were black. The fibre strength of JRO 524 was fairly good and was distinct from JRO 8432 and JRO 128 whose fibre strength was good. But the fibre fineness of JRO 128 was very fine and was distinct from JRO 8432 whose fibre fineness was fine. Out of 2 tall *olitorius* varieties JRO 7835 had unique character, root primordia modified as spine like outgrowth at the base of the stem that was not found in any other *olitorius* variety and this character distinguished JRO 7835 from JRO 36E.

Out of 8 premature flowering susceptible *olitorius* varieties 5 (JRO 632, JRO 66, JRO 3690, Chinsurah green and TJ 40) had green stem colour, two varieties (KOM 62 and JRO 620) had red stem colour and only one variety, Bidhan Rupali, had pale green stem colour. Bidhan Rupali was distinct from all other *olitorius* varieties for pale green stem colour. Out of 2 premature flowering susceptible red stem coloured varieties KOM-62 was medium and JRO 620 was tall with regard to plant height and they were distinct for this character.

Out of 5 green stem coloured varieties Chinsurah Green was early and was distinct, JRO 66 had non-dehiscent pod, JRO 632 had medium seed size, JRO 3690 has steel grey, whereas TJ 40 had green seed coat colour and they were distinct from each other.

Among *capsularis* varieties, 3 varieties, viz. JRC 321, Padma and UPC 94 had coppery red stem and all others had green stem (Fig. 4). JRC 321 and UPC 94 were early flowering type whereas Padma was late flowering type. Padma was distinct from all other *capsularis* varieties but JRC 321 was similar to UPC 94. Out of 11 green stem coloured varieties Bidhan Pat 2 and JRC 212 were early with regard to time of 50% flowering and other nine were late varieties. On the basis of plant height D-154, KC-1, KTC-1 and JRC-80 were short. Out of these 4 short varieties, 3 varieties viz. KC-1, KTC-1 and JRC-80 had green petiole and D-154 had red petiole and was distinct. KTC-1 had large seed and was distinct from KC-1 and JRC-80 with extra-large seed. On the other hand, five varieties (viz. JRC 7447, JRC 4444, JRC 698, Bidhan Pat-1 and Bidhan Pat-3 had medium plant height. Among these five varieties JRC 4444 was distinct for its fine fibre while remaining three varieties JRC 7447, JRC 698 and Bidhan Pat-3 had very fine fibre. On the basis of fibre strength these three varieties (JRC 7447, JRC 698 and Bidhan Pat-3) had fairly good, good and fairly average fibre strength, respectively and they were distinct from each other. Therefore, out of 14 *capsularis* varieties distinctiveness could be established for seven varieties, viz. Padma, D-154, JRC 4444, KTC-1, Bidhan Pat 3, JRC 7447 and JRC 698. It may be mentioned here that Kumar et al. (2006) could establish distinctiveness of only few varieties in both the species by using 16 morphological characters prescribed in the Draft National Test Guidelines of Jute (Kumar and Mahapatra, 2004) but distinctiveness of almost all the varieties of *olitorius* and seven varieties of *capsularis* could be established by using 17 characters of the revised official DUS Test Guidelines of Jute (PPV&FRA 2008). Similar attempts for establishment of

distinctness were made in soybean (Ravikumar and Naraayanswamy, 1999), oat (Kumar et al. 2002), rapeseed-mustard (Gupta et al. 2003; Yadav 2004), pearl millet (Kumar *et al*., 2004), rice (Joshi *et al*., 2007; Patra *et al*., 2010), jute (Kumar *et al*., 2008) and maize (Yadav and Singh, 2010).

It may be concluded that on the basis of 17 morphological characteristics identity and distinctiveness of almost all the varieties in *olitorius* and seven varieties in *capsularis* could be established individually and remaining varieties of *capsularis* could be classified into two or more groups. However, the dummy candidate variety, Bidhan Rupali in *olitorius* was distinct from all other *olitorius* varieties. But the dummy candidate variety, JRC 321, was similar to UPC 94. Therefore, the revised set of 17 characters included in the Official DUS Test Guidelines of Jute is found to be more effective in distinguishing the jute varieties.

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