

Original Research Article

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Exploration, Characterization and Conservation of Cotton (*Gossypium* spp.) Encompassing Colour Cotton from Tripura, India

M. Saravanan¹, R. C. Misra², S. S. Mahajan¹, P. Mohan¹ and V. N. Waghmare^{1*}

¹ICAR-Central Institute for Cotton Research, Nagpur, Maharashtra, India

²ICAR-National Bureau of Plant Genetic Resources, Regional Station, Cuttack-753006,
Odisha, India

*Corresponding author

ABSTRACT

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Exploration survey was conducted in Tripura state to collect, characterize and conserve the valuable traditional cultivars of *desi* cotton. Fourteen germplasm accessions comprising ten *Gossypium arboreum* L. and four *Gossypium barbadense* L. were collected from Gomati, Khowai, West Tripura and Dhalai districts of Tripura. The collected accessions of *desi* cotton (*G. arboreum*) represent derivatives of race ‘*cernuum*’ and ‘*burmanicum*’. The morphological variants of *desi* cotton were compact, having short sympodia, medium size boll with short staple fibre. The range for fibre quality traits such as fibre length (17.2 - 19.1 mm), fibre strength (15.0 - 16.7 g/tex), micronaire (>7), Elongation Index (4.1- 4.6) and Short Fibre Index (45.1 - 61.4) was recorded for *desi* cotton. Among *G. arboreum* accessions, two were naturally coloured light brown and brown linted cotton. The range of fibre quality traits with respect to fibre length (32.6 - 34.9 mm), micronaire (5.8 - 6.4) and fibre strength (21.6 - 24.7 g/tex) was recorded in *G. barbadense* collection. The cotton accessions were conserved in the Field Gene Bank and medium term cold storage at ICAR-Central Institute for Cotton Research, Nagpur for future utilization in cotton improvement.

Introduction

Cotton is an important fibre, animal feed and oil seed crop. Because of its commercial value, it is popularly referred as “White Gold”. India is the sole country in the world to grow all four cultivated species which includes two diploids ($2n=2x=26$) *G. arboreum* and *G. herbaceum* and two tetraploids ($2n=2x=52$) *G. hirsutum* and *G. barbadense*. India is considered to be the

centre of origin for cultivated Asiatic species *Gossypium arboreum* L., that reported to be domesticated into three geographical races, namely *bengalense*, *cernuum* and *indicum* (Hutchinson *et al.*, 1947). The dispersal of race ‘*indicum*’ is considered eastward to north eastern India and Myanmar formed another race ‘*burmanicum*’ (Kulkarni *et al.*, 2009). They possess invaluable genetic resources of innumerable genes that confer resistance to biotic and abiotic stresses such as ability to

withstand drought, heat, salinity and sodicity (Maqbool *et al.*, 2010; Tahir *et al.*, 2011); tolerance to pests and disease, including bollworms (Dhawan *et al.*, 1991); aphids, leaf hoppers (Nibouche *et al.*, 2008); rust, fungi (Wheeler *et al.*, 1999); viral diseases (Mehetre *et al.*, 2004; Akhtar *et al.*, 2010) and many adaptive features.

Tripura is one of the seven sisters that form the North-Eastern Region of India. It is a tribal dominated state in this region. Jhum cultivation (slash-burn-sow method of agriculture) is the major traditional method of cultivation which is primarily adopted since generations. Cotton is always being cultivated as a mixed crop instead of sole crop. The other cultivated crop includes maize, gingely, red gram and different vegetables. Farmers from NEH region have been cultivating *desi* cotton including coloured cotton since ages. In India, natural *desi* cotton was popular in some states *viz.*, Karnataka, Andhra Pradesh and West Bengal. *Manipur Khaki*, *Coconadas-1* and *Coconadas-2* were important cultivars grown in our country and particularly *Coconadas* were exported to Japan at premium prices (Kranthi, 2014). Due to low productivity per unit area, poor fibre characteristics and non-uniformity colours, colour cotton cultivation in India was totally replaced by white linted genotypes (Waghmare and Koranne, 1998). Because of the artificial dying in the textile sector, the chemicals are polluting the river and aquatic ecosystem including the ground water resources to some extent. Now there is growing concern about sustainable agriculture and management of aquatic ecosystem. Therefore, coloured cotton is highly suitable for cultivation of sustainable organic agriculture and also useful for export oriented eco-friendly garments. The objective of exploration was to collect, characterize and conserve the germplasm and traditional cultivars of cotton for crop improvement studies.

Materials and Methods

Exploration and collection survey of cotton from Tripura

Based on information from literature survey and gap analysis, ICAR-National Bureau of Plant Genetic Resources, New Delhi in collaboration with ICAR-Central Institute for Cotton Research, Nagpur conducted an expedition survey to collect primitive cultivars of cotton from the state of Tripura (Fig. 1). All standard principles and procedures including sampling techniques were followed in our exploration study as per the guidelines laid out by ICAR-NBPGR, New Delhi (Pareek *et al.*, 2000). At the collection site, identification and preliminary characterization was carried as per the Germplasm Index Card formulated by ICAR-CICR, Nagpur which includes a range of morphological characteristics, response to diseases and pests.

Morphological characterization

The collected cotton accessions were sown in augmented design at ICAR-CICR main research farm, Panjari, Nagpur for characterization (Fig. 2). Agro-morphological traits including DUS characterization was recorded taking five plants of each accession for 30 characters. After ginning, the samples were sent to Ginning Training Centre (GTC), ICAR-Central Institute for Research on Cotton Technology, Nagpur for fibre quality analysis. The germplasm of collected accessions were conserved in the midterm storage module of ICAR- CICR, Nagpur.

Results and Discussion

The yield levels have reached a plateau due to the narrow genetic base in cotton. To broaden the genetic base for further improvement, it is necessary to collect, characterize, evaluate,

conserve, document and utilize the genetic diversity. Based on gap analysis and literature survey, an exploration survey was undertaken in Gomati, Khowai, West Tripura and Dhalai districts of Tripura. Fourteen morphological variants of traditional cotton including two germplasm accessions representing *desi* coloured cotton (Fig. 3) were collected from diverse collection sites such as jhum cultivated areas, homesteads/ kitchen gardens, bunds of nala, farm/ store etc. Agro-morphological characterisation including DUS attributes was carried out for all cotton accessions at the institute (Table 1). The *desi* cotton variants were compact types, having short sympodia, medium size boll with short staple and coarse fibre. The collected *G. arboreum* accessions represent derivatives of

race '*cernuum*' and race '*burmanicum*' (Fig. 4). These accessions bore long bursted bolls measuring up to 15 cm. The range of fibre quality traits recorded for *desi* cotton with respect to fibre length that varies from 17.2 to 19.1 mm, fibre strength from 15.0 to 16.7 g/tex, micronaire up to >7, Elongation Index from 4.1 to 4.6 and Short Fibre Index from 45.1 to 61.4. Among collected *desi* cotton, two accessions viz. RCM/PM/MS-8 and RCM/PM/MS-9 were naturally coloured having light brown to brown linted fibres. A total of 33 samples are collected from West Garo hills of North East Hill region that represents a range of characteristics such as large bracts, long petiole, elongated capsule, early maturity, burst capsule length up to 7 inches and bollworm tolerance.

Table.1 Variability index for morpho-economic characters

Sl. No	Acc. number	Species	Habit/ Leaf	Flower	Fruit	Seed	Lint colour	Average boll weight
1.	RCM/PM/MS-1	<i>Gossypium arboreum</i>	Annual; deeply palmate, lobed, with short sinus	Corolla yellow, 5 petals, pollen yellow, petal spot present, bracteoles 3, broad, triangular, persistent, calyx cup shaped	Capsule oval to oblong, pointed beak, 3-4 locular	Pointed apex, ovoid to globose	White	4.5 – 5.0
2.	RCM/PM/MS-2	<i>Gossypium arboreum</i>	Annual, deeply palmate, lobed, deep sinus	Corolla yellow, 5 petals, pollen yellow, petal spot present, bracteoles-3, broad, triangular, persistent, calyx cup shaped	Capsule oval to oblong, pointed beak, 3-4 locular	Pointed apex, ovoid to globose	White	3.8 – 5.0
3.	RCM/PM/MS-3	<i>Gossypium arboreum</i>	Annual, palmate, deep sinus	Corolla yellow, 5 petals, pollen yellow, petal spot present, bracteoles-3, broad, triangular, persistent, calyx cup shaped	Capsule oval to oblong, pointed beak, 3- locular	Pointed apex, ovoid to globose	White	2.5 – 4.3
4.	RCM/PM/MS-4	<i>Gossypium arboreum</i>	Annual, palmate, deep sinus	Corolla yellow, 5 petals, pollen yellow,	Capsule oval to oblong, pointed beak,	Pointed apex, ovoid to	White	2.5 – 5.0

				petal spot present, bracteoles-3, broad, triangular, persistent, calyx cup shaped	3 -locular	globose		
5.	RCM/PM/MS-8	<i>Gossypium arboreum</i>	Annual, deeply palmate, lobed with short sinus	Corolla yellow, 5 petals, pollen yellow, long claw, petal spot present, bracteoles-3 broad, triangular, persistent, calyx-cup shaped	Capsule oval to oblong, pointed beak, 3 -locular	Pointed apex, ovoid to globose	Light brown	3.5 - 4.8
6.	RCM/PM/MS-9	<i>Gossypium arboreum</i>	Annual, deeply palmate, leaf lobed with short sinus	Corolla yellow, 5 petals, pollen yellow, long claw, petal spot present, bracteoles-3 broad, triangular, persistent, calyx-cup shaped	Capsule oval to oblong, pointed beak, 3 -locular	Pointed apex, ovoid to globose	Brown	3.5 - 5.0
7.	RCM/PM/MS-11	<i>Gossypium arboreum</i>	Annual, palmate, 4-5 lobed, accessory lobe absent, short sinus	Corolla yellow, 5 petals, pollen yellow, long claw, petal spot present, bracteoles-3 broad, triangular, persistent, calyx-cup shaped	Capsule oval to oblong, pointed beak, 3-4 locular	Pointed apex, ovoid to globose	White	4.0 - 5.5
8.	RCM/PM/MS-12	<i>Gossypium arboreum</i>	Annual, palmate, 4-5 lobed, accessory lobe absent, short sinus	Corolla yellow, 5 petals, pollen yellow, long claw, petal spot present, bracteoles-3 broad, triangular, persistent, calyx-cup shaped	Capsule oval to oblong, pointed beak, 3-4 locular	Pointed apex, ovoid to globose	White	3.8 - 5.0
9.	RCM/PM/MS-13	<i>Gossypium arboreum</i>	Annual, palmate, 4-5 lobed, accessory lobe absent, short sinus	Corolla yellow, 5 petals, pollen yellow, long claw, petal spot present, bracteoles-3 broad, triangular, persistent, calyx-cup shaped	Capsule oval to oblong, pointed beak, 3-4 locular	Pointed apex, ovoid to globose	White	4.0 - 5.0
10.	RCM/PM/MS-15	<i>Gossypium arboreum</i>	Annual, palmate, 4-5 lobed, accessory lobe absent,	Corolla yellow, 5 petals, pollen yellow, short claw, petal spot present,	Capsule oval to oblong, pointed beak, 3-4 locular	Pointed apex, ovoid to globose	White	3.8 - 5.5

			short sinus	bracteoles-3 broad, triangular, persistent, calyx-cup shaped				
11.	RCM/PM/MS-5	<i>Gossypium barbadense</i>	Perennial, broadly palmate, central lobe long, sinus modified into folds	Corolla long narrow, pale yellow, petal blotch absent, calyx cup shaped, ovary tri- to tetra- locular	Capsule ovoid, 3-4 locular, opening pattern imperfect	Bold apex, ovoid	White	1.3 - 1.5
12.	RCM/PM/MS-6	<i>Gossypium barbadense</i>	Perennial, broadly palmate, central lobe long, sinus modified into folds	Corolla long narrow, pale yellow, petal blotch absent, calyx cup shaped, ovary tri- to tetra- locular	Capsule ovoid, 3-4 locular, opening pattern imperfect	Bold apex, ovoid	White	1.3 - 2.0
13.	RCM/PM/MS-10	<i>Gossypium barbadense</i>	Perennial, broadly palmate, central lobe long, sinus modified into folds	corolla long narrow, pale yellow, petal blotch absent, calyx cup shaped, ovary tri- to tetra- locular	Capsule ovoid, 3-4 locular, opening pattern imperfect	Bold apex, ovoid	White	1.3 - 1.8
14.	RCM/PM/MS-14	<i>Gossypium barbadense</i>	Perennial, palmate, lobes ovate-oblong, sinus modified into folds	Corolla long narrow, pale yellow, petal blotch absent, calyx cup shaped, ovary tri- to tetra- locular	Capsule ovoid, 3-4 locular, locules opening pattern imperfect	Bold apex, ovoid	White	1.5 - 2.0

Table.2 Variability index in fibre quality traits

Sl. No.	Collector No.	2.5% SL length (mm)	Uniformity ratio (%)	Fineness micronaire 10-6 g/in	Bundle strength tenacity (g/tex) at 3.2 mm gauge	Elongation index %	Short fibre index
1.	RCM/PM/MS-1	17.3	56	>7.0	15.9	4.3	61.4
2.	RCM/PM/MS-2	17.2	56	>7.0	15.2	4.2	60.0
3.	RCM/PM/MS-3	17.6	55	>7.0	16.7	4.1	55.3
4.	RCM/PM/MS-4	19.1	55	>7.0	16.3	4.2	49.5
5.	RCM/PM/MS-8	17.6	56	>7.0	15.0	4.6	51.4
6.	RCM/PM/MS-9	17.6	56	>7.0	15.4	4.2	55
7.	RCM/PM/MS-11	19.0	53	>7.0	15.7	4.2	45.1
8.	RCM/PM/MS-12	17.2	56	> 7.0	15.1	4.3	59.4
9.	RCM/PM/MS-13	17.8	57	>7.0	16.6	4.2	56.8
10.	RCM/PM/MS-15	19.0	53	>7.0	15.7	4.1	54.2
11.	RCM/PM/MS-5	32.6	49	6.1	23.9	5.7	4.7
12.	RCM/PM/MS-6	33.6	48	5.8	23.0	5.8	5.1
13.	RCM/PM/MS-10	34.9	51	6.0	24.7	5.5	4.4
14.	RCM/PM/MS-14	33.0	48	6.4	21.6	5.3	5.0
Range		17.2-34.9	48-57	5.8- > 7	15.0-24.7	4.1-5.8	4.4-61.4

Fig.1 Collection sites of cotton (*Gossypium* spp.) germplasm accessions from Tripura, India

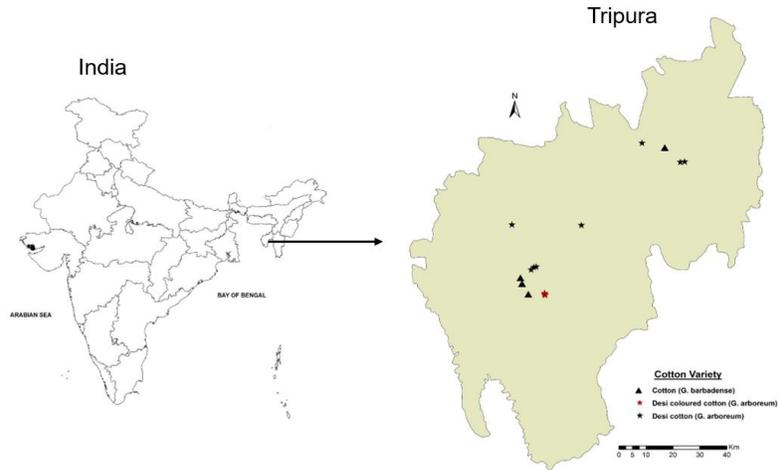


Fig.2 *Desi* cotton accessions (*Gossypium arboreum*) in experimental field at Pajri farm, ICAR-CICR, Nagpur



Fig.3 a. *Desi* colour cotton plant (*Gossypium arboreum*) at Kalsibari village, Gomati district, Tripura



Fig.3b Capsule



Fig.3c Brown colour lint



Fig.4a *Desi* cotton plant (*Gossypium arboreum*) at Uttar Barmura, Gomati district, Tripura



Fig.4b Capsule with burst boll and lint



Fig.5a *Gossypium barbadense* in a homestead at Twirupa, Gomati district, Tripura



Fig.5b Leaves



Fig.5c Twig with flower, capsule and burst boll



The collected cotton germplasm materials possess considerable variability in desirable traits, namely average seed cotton yield per plant (24-82 g), boll weight (4.9-7.3 g), ginning out-turn (37-46%), mean halo length (18-22mm) and resistance to various pests and diseases (Singh *et al.*, 2003). ICAR-NBPGR, New Delhi collaborate with ICAR-CICR, Nagpur explore and collect landraces and primitive cultivars from Assam & Manipur (1977,1984) particularly *G. arboreum* race *cernuum* having high ginning out-turn, big & long bolls and locule retention with high seed number (Narayanan *et al.*, 2014). ICAR-CICR conducted exploration and collection survey to collect landraces and primitive cultivars from Arunachal Pradesh. The collected accessions represent derivatives of race 'cernuum' and race 'burmanicum' that show broad variability index for morpho-economic characters such as leaf size, boll size and shape. The range of variability is recorded for *G. arboreum* variants of landraces with reference to fibre length (17.61-24.56mm), micronaire (5.53-7.25) and fibre strength (15.42-17.89 g/tex) (Saravanan *et al.*, 2016). Among fourteen accessions, four are of *G. barbadense* accessions from Tripura (Fig. 5). The range of fibre quality traits for *G. barbadense* with reference to fibre length varies from 32.6 to 34.9 mm, micronaire from 5.8 to 6.4 and fibre strength from 21.6 to 24.7 g/tex (Table 2). The high micronaire value in the *G. barbadense* underscored diverse germplasm material present in the collection.

The primitive cultivars and landraces of *desi* cotton in Tripura are under biotic influences of several kinds and magnitudes and exhibited considerable amount of shrinkage in area due to conversion of lands to rubber cultivation and rapid introduction of new varieties/Bt hybrids/ improved cultivars. These primitive cultivars are the basic source as genetically diverse material for cotton improvement and needs utmost attention for conservation. The

present exploration mission was made to collect available diverse cotton accessions of *desi* cotton (*G. arboreum*) and *G. barbadense* accessions from four districts of Tripura. The collected accessions were genetically diverse based on agro-morphological traits which may be used in cotton improvement programme. *Desi* coloured cotton cultivation is highly suitable for sustainable organic farming and also preparation of export oriented eco-friendly garments and cotton improvement.

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