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# Cytomorphological studies in $F_1$ hybrids (*Corchorus capsularis* L. × *Corchorus trilocularis* L.) of jute (Tiliaceae)

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**Abstract.** Cytomorphological features of $F_1$ hybrids (12 sets were analyzed; $F_1$ plants raised from seeds of each crossed pod was considered as a single set) between *Corchorus capsularis* Linnaeus – 2n = 14 (male parent) and *C. trilocularis* Linnaeus – 2n = 14 (female parent) were studied in relation to parents. The hybrid plants looked morphologically alike in 12 sets. The $F_1$'s were intermediate to parents for few traits (stem colour, bud shape and flower colour); while, for other characters (pod colour, pod shape, seed colour and seed shape) they resembled the female parent. Average chromosome association per cell at diplotene and metaphase I (MI) of $F_1$ plants was 0.007 hexavalent (VI) + 0.007 quadrivalent (IV) + 6.74 bivalent (II) + 0.70 univalent (I) [parents: *C. capsularis* – 6.98 II + 0.03 I /cell, *C. trilocularis* – 7II /cell] and it varied from 0.05 VI + 4.00 II + 2.00 I to 8.86 II + 0.00 I among the sets. F1 plants formed bivalents (4.00 to 8.86 /cell, frequency – 0 to 14/cell) and univalents (0.00 to 2.00 /cell, frequency – 0 to 24/cell) mostly and very rarely quadrivalents (0.07/cell, set-7) and hexavalents (0.05/cell, set-5) in ring configurations. Predominant associations in F1 plants were 7 II (39.47% to 94.44%; average 70.17%) and 6 II + 2I (0.00% to 30.77%, average 11.08%). PMC's (pollen mother cells) with aneuploidy (hypo - and hyperploids) and polyploidy (n=1, 2, 3, 4, 5, 8, 10, 12 and 14) were noted in some hybrid lines (set-1, 2, 5, 6, 7, 8 and 10) at diplotene and MI only, which was attributed to the consequence of cytomixis. Cytomixis was evident from all hybrid lines including the female parent *C. trilocularis* L. Anaphase I showed equal (7/7) segregation of chromosomes in 100.0% cells of both parents and in 96.5% cells of hybrid plants. Pollen fertility was high ($F_1$ plants: 79.7% to 95.6%, average – 89.1%; parents: *C. capsularis* L. – 91.2%, *C. trilocularis* L. – 73.3%) in the plant types. Results indicated close genetic relationship between the parents.

**Key words:** *Corchorus capsularis*, *C. trilocularis*, jute, $F_1$ hybrid, cytomorphology, aneuploid and polyploid PMCs, cytomixis.

## INTRODUCTION

*Corchorus capsularis* Linnaeus and *C. olitorius Linnaeus* (2n = 14) are important fibre yielding plants of commerce, distributed throughout the warmer regions of the world (Kundu, 1951; Purseglove, 1968). Apart from the two cultivated members of jute, eight wild (*C. aestuans* Linnaeus, *C. fascicularis* Lamarck, *C. pseudoolitorius* Islam et Zaid, *C. tridens* Linnaeus, *C. trilocularis* Linnaeus, *C. urticaefolius* Wight et Arnott, *C. depressus* (Linnaeus), and *C. velutinus* Wild) species are also reported from India (Mahapatra et al., 1998). The wild germplasms though poor fibre yielder, are important genetic resources for disease resistance (Palve et al. 2004) and fine fibre (Mahapatra, Saha, 2008) traits. Among the wild species, *C. trilocularis* has been specifically identified as the only tolerant genotype to water inundation (Mahapatra, Saha, 2008). Conservation of wild germplasms and their exploitation through interspecific hybridization with cultivated species of jute should be efficient for genetic diversity in plants. In this direction reports are rather meager: *C. aestuans*, 2n = 14 × *C. capsularis*, 2n = 14 (Islam, Sattar, 1961); *C. trilocularis*, 2n = 14 × *C. capsularis* (Faruqui, 1962; Arangzeb, Khatun, 1980); *C. aestuans* × *C. olitorius* (Haque, Islam, 1970); however, the elite strain 'Tri Cap' has been evolved as the consequence of successful crossings between *C. capsularis* and *C. trilocularis* (Khatun, 2007). The present paper is an additional endeavor in this regard and documents cytomorphological behavior of $F_1$ hybrids developed from crossings between *C. capsularis* × *C. trilocularis.* Meiotic behavior of hybrid plants will provide valuable information regarding species interrelationship.

## MATERIALS AND METHODS

Crossings (fifteen crosses performed) between *C. capsularis* (JRC 321 – used as male parent) and *C. trilocularis* (KBA 222 used as female parent) yielded twelve pods. *C. trilocularis* has been used as female parent in the crosses with the objective to conserve the gene pool of the wild species. Seeds from each pod (considered as set) were sown in separate lines (set-1 to 12, indicated lines obtained following sowing of seeds from each pod; 20 seeds in each case) in the experimental plots of Botanical Garden, Kalyani University to raise F1 plants (79 plants obtained from a total of 240 seeds sown – 32.92% germination as compared to 84.0% and 24.0% in C. capsularis and *C. trilocularis*). Morphological attributes of $F_1$ plants in comparison to their parents were analyzed (data pooled over 10 to 15 plants from each category).

Microsporogenesis was observed from fixed young flower buds (6 a.m. to 7 a.m.) of suitable stages of development in Carnoy's solution (6:3:1) and 2 to 3 changes were given in the fixative at the interval of 24 hour. Pollen mother cells (PMCs) and pollen obtained from anther (microsporophyll) squash preparations were stained in 2% propionocarmine solution. Fully stained pollen grains were considered fertile. Meiotic data of parents and F1 hybrid plants were recorded from diplotene, metaphase I (MI) and anaphase I (AI) cells. Hexavalent, quadrivalent, bivalent and univalents have been marked as VI, IV, II and I, respectively, in the text. Photomicrographs were taken from temporary squash preparations.

## RESULTS AND DISCUSSION

### Morphology

Morphological characters of parents and $F_1$ hybrid are presented in Table 1. The hybrid plants looked uniform among the sets. The $F_1$'s for few traits (stem colour, bud shape and flower colour) were intermediate to parents; while, for some characters (pod and seed colour and shape) they resembled the female parent. Data recorded for quantitative traits in $F_1$ hybrids were however mostly found to be lower than either of the parents.

### Cytology

Meiotic data of parents and $F_1$ hybrid plants are presented in Table 2. Control plants had always 2n = 14 in their meiocytes; while $F_1$ plants showed 2n = 14 (66.67% to 100.00%; average – 88.11%), 2n < 14 (0.00% to 23.68%; average – 3.63%) and 2n > 14 (0.00% to 28.57%; average – 8.26%) in their PMCs (Figs1-18). Mean chromosome association per cell at diplotene and MI pooled over F1 plants were es-

**Table 1.** Morphological attributes of parents and $F_1$ hybrid.

| **Characters** | ***C. capsularis*** | ***C. trilocularis*** | **$F_1$** |
|---|---|---|---|
| Plant height (cm) | 153.86 ± 6.55 | 95.4 ± 5.44 | 84.45 ± 1.56 |
| Nature of stem | Terrete, solid, woody, glabrous | Terrete, solid, woody, glabrous | Terrete, solid, woody, glabrous |
| Colour of stem | Dull green | Greenish purple | Green |
| Leaf shape | Ovate- lanceolate,acuminate | Ovate- lanceolate,acuminate | Ovate- lanceolate,acuminate |
| Leaf area($cm^2$) | 22.30 ± 1.18 | 10.04 ± 0.86 | 14.11 ± 0.75 |
| Bud shape | Rounded, yellow | Pyriform, yellow | Pyriform / ovoid, dull yellow |
| Flower colour | Yellow | Yellow | Dull yellow |
| Pod colour | Dull green | Green with light purple shades | Green |
| Pod shape | Globose to subglobose, depressed above, glabrous | Elongated, cylindrical, glabrous | Cylindrical, glabrous |
| Capsule size (cm) | 0.93 ± 0.08 × 0.77 ± 0.04 | 7.5 ± 0.29 × 0.30 ± 0.09 | 2.88 ± 0.07 × 2.5 ± 0.29 |
| Seed colour | Brown | Black | Black |
| Seed shape | Triangular | Angular, ellipsoid | Angular |
| Seed size (mm) | 2.69 ± 0.16 × 1.69 ± 0.08 | 1.17 ± 0.06 × 0.78 ± 0.04 | 1.15 ± 0.12 × 0.90 ± 0.06 |
| 100 seed weight (mg) | 251.67 ± 1.67 | 66.0 ± 1.00 | 52.58 ± 1.11 |
| Seed viability (%) | 95.0 | 60.0 | 55.0 |
| Days of maximum flowering | 115-120 | 85-90 | 98-110 |

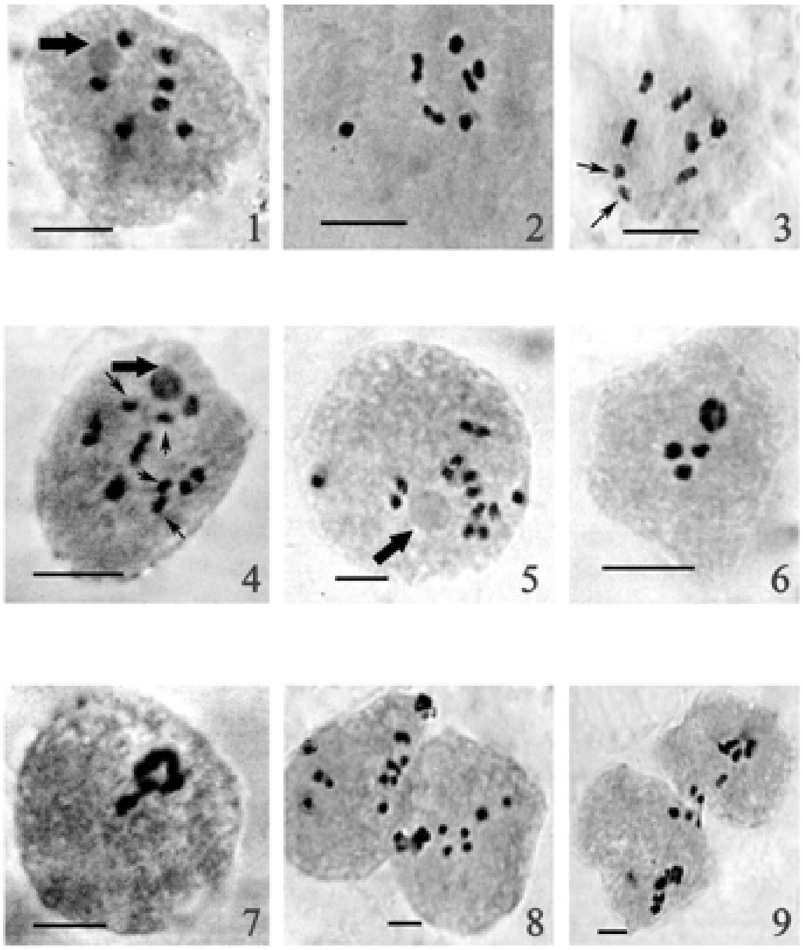
timated to be 0.007 hexavalent (VI) + 0.007 quadrivalent (IV) + 6.74 bivalent (II) + 0.70 univalent (I) (parents: *C. capsularis* – 6.98 II + 0.03 I/cell; *C. trilocularis* – 7 II/cell) and it varied from 0.05 VI + 4.00 II + 2.00 I (set - 5) to 8.86 II + 0.00 I (set - 6) among the sets. $F_1$ plants formed bivalents (4.00 to 8.86/cell; frequency: 0 – 14/cell) and univalents (0.00 to 2.00/cell; frequency: 0-24/cell) mostly among the sets and they showed non-random ($p < 0.001$) distribution as evidenced from $\chi2$- test of heterogeneity. Univalents were found to lie in close proximity to one another (Figs 3-4). Quadrivalents (0.07/cell, set - 7) and hexavalents (0.05/cell, set -5) formed rarely (Figs. 6 - 7) ring configurations. PMCs with 14 I (set-1: 4.17%, Fig. 5) and 24 I (set-5: 2.47%, Fig. 17) were also studied. A meiocyte (1.23%) analyzed from set-5 showed 9 II +3 I (Fig. 16) formation. $F_1$ plants formed 7 II (39.47% to 94.44%; average over the sets – 70.17%, Figs 1-2) predominantly followed by 6 II + 2 I (0.00 to 30.77%; average-11.08%, Fig. 3). Aneuploid (hypoploid and hyperploid) and polyploid (n = 1, 2, 3, 4, 5, 8, 10, 12 and 14) PMCs (Figs 6, 7, 10-18) were observed in seven F1 hybrid lines (S-1, 2, 5, 6, 7, 8 and 10) at diplotene and MI (excepting 2 cells of set -1 with 14/14 segregation of chromosomes at AI) only, thereby indicating that possibly those meiocytes have failed to survive beyond MI stage of division. In F1 plants, hyperploidy (8.26%) was higher than hypoploidy (3.63%). AI cells demonstrated equal (7/7) segregation

**Table 2.** Meiotic configurations and pollen fertility in parents and in F$_1$ hybrid plants. I, II, IV, VI – univalents, bivalents, quadrivalents, hexavalents.

| Genotypes | PMCs scored at diplotene and MI | Mean/ cell | | | | Numerical variations (%) | | | No. of pollens analyzed | Pollen fertility (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | IV | VI | $2n<14$ | $2n=14$ | $2n>14$ | | |
| Parents:<br>*C. capsularis* | 74 | 0.03 | 6.98 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 1183 | 91.2 |
| *C. trilocularis* | 57 | 0.00 | 7.00 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 1354 | 73.3 |
| F1 hybrid:<br>Set - 1 | 76 | 1.79 | 5.58 | 0.00 | 0.00 | 23.68 | 68.42 | 7.89 | 429 | 79.7 |
| Set - 2 | 32 | 0.63 | 6.88 | 0.00 | 0.00 | 0.00 | 93.75 | 6.25 | 512 | 85.4 |
| Set - 3 | 36 | 0.17 | 6.92 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 432 | 95.6 |
| Set - 4 | 30 | 0.27 | 6.87 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 324 | 94.4 |
| Set - 5 | 44 | 2.00 | 4.00 | 0.00 | 0.05 | 9.09 | 68.18 | 22.73 | 581 | 89.8 |
| Set - 6 | 28 | 0.00 | 8.86 | 0.00 | 0.00 | 0.00 | 71.43 | 28.57 | 432 | 84.7 |
| Set - 7 | 30 | 0.67 | 8.07 | 0.07 | 0.00 | 6.67 | 66.67 | 26.67 | 507 | 82.8 |
| Set - 8 | 48 | 0.33 | 6.79 | 0.00 | 0.00 | 4.16 | 91.67 | 4.16 | 228 | 85.9 |
| Set - 9 | 34 | 0.35 | 6.82 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 377 | 95.2 |
| Set - 10 | 70 | 0.29 | 7.00 | 0.00 | 0.00 | 0.00 | 97.14 | 2.86 | 506 | 86.2 |
| Set - 11 | 58 | 1.10 | 6.45 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 402 | 94.8 |
| Set - 12 | 52 | 0.77 | 6.62 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 426 | 94.1 |
| Pooled over the hybrids | 538 | 0.70 | 6.74 | 0.007 | 0.007 | 3.63 | 88.11 | 8.26 | 5156 | 89.1 |

of chromosomes in the plant types (*C. capsularis* – 100.0%, 45 cells analyzed; *C. trilocularis* – 100.0%, 28 meiocytes estimated; hybrid lines – 96.5%, 366 PMCs scored) mostly (excepting set-1 and set-6 with occasional laggards). Pollen fertility (parents: *C. capsularis* – 91.2%, *C. trilocularis* – 73.3%) among the sets varied from 79.7% to 95.6% (average: 89.1%).

Aneuploid and polyploid variation in chromosome number at prophase I /and metaphase I (Figs 8-9) in some hybrid lines was possibly due to the consequence of cytomictic behaviour of chromosomes (migration of chromatin from one cell to another). Such chromosomal variations occurring due to cytomixis were reported earlier (Sarvella, 1958; Gottschalk, 1970; Sapre, Deshpande, 1987; Datta et al., 2005). It is rather interesting to note that although cytomixis was evident in all hybrid lines including the female parent *C. trilocularis*, aberrant meiocytes could only be detected in few cases. Therefore, it may be suggested that cell clusters showing chromatin agglutination and sticky connections during early stages of prophase I might vary in their cytomictic potential and in some cases possibly failed to continue the process.



**Figs 1-9**. Meiotic configurations of $F_1$ hybrid. **1** - 7 II at diplotene. **2** - 7 II at MI. **3** - 6 II + 2 I at MI. **4** - 5 II + 4 I at diplotene. **5** - Diplotene showing 14 I. **6** - 1 IV + 3 II (2n = 10) at MI. **7** - PMC with 1 VI + 1 II (2n = 8) at MI. **8** - PMC showing cytomixis at MI. **9** - Chromosome migration between meiocytes at MI. Thin arrows indicate univalents, thick arrows indicate nucleoli. Bar = 10μm.

Chromosome pairing in interspecific hybrids has been of paramount significance in ascertaining relationship between parents. Regular pairing behaviour of chromosomes (7 II formation in 70.17% meiocytes), high pollen fertility (89.1%) and uniform morphological characteristics observed in $F_1$ plants suggested close genetic harmony between the parents.

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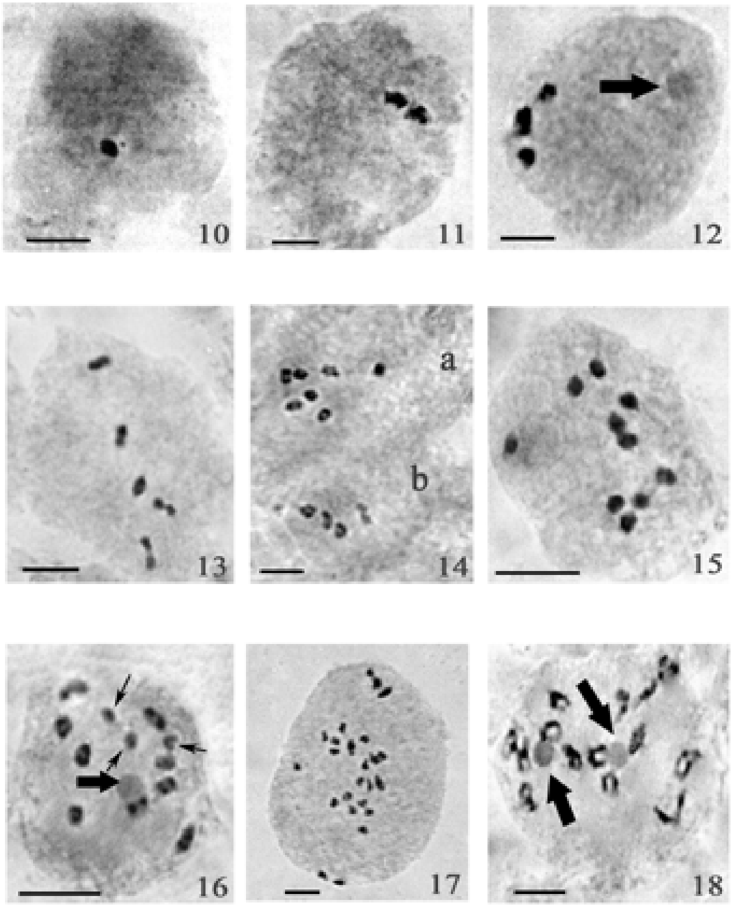

**Figs 10-18**. Aneuploid and polyploid PMCs in $F_1$ hybrid. **10** - n = 1 at MI. **11** - n = 2 at MI. **12** - n = 3 at diplotene. **13** - n = 5 at MI. **14** - n = 7 (a) and n = 4 (b) at MI. **15** - PMC with 1 II +8 I (2n = 10) at MI. **16** - Meiocyte showing 9 II + 3 I at diplotene. **17** - 24 I at MI. **18** - 14 II at diplotene. Thin arrows indicate univalents, thick arrows indicate nucleoli. Bar = 10µm.

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