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Spontaneous desynapsis in *Corchorus fascicularis* Lamk. (Family: Tiliaceae)

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Abstract: A desynaptic mutant of *Corchorus fascicularis* Lamk. (Family: Tiliaceae) showing distinctive morphological variations than normal was identified from the natural population (1 out of 27 plants scored) of jute species following male meiotic analysis. Self segregation of the desynaptic plant suggested that desynapsis (mutant trait) was monogenic recessive to normal. Compared to normal plants, the spontaneous desynaptic mutant (medium strong type) demonstrated enhanced univalent frequency per cell (4.05, normal-0.31), reduced number of chiasma (6.67, normal- 7.28) and bivalent (5.12, normal- 6.99) per nucleus, few meiocytes (13.64%, normal-5.36%) with unequal separation at AI, cytologically near normal AII (94.83%, normal- 100.00%) cells and high male fertility (81.77%, normal- 92.06%). Cytomixis (prophase I/ metaphase I) was evident in both normal and mutant plants forming aneuploid (mutant: 2n< 14-1.40%, 2n> 14-2.80%; normal: 2n<14 - 14.20%, 2n>14 - 10.22%) PMCs predominantly at MI (mutant: 4.20%, normal: 24.42%) and rarely in AI (mutant: 1.52%, normal: 1.79%) cells.

Keywords: *Corchorus fascicularis,* desynapsis, medium strong type, monogenic recessive, morphological variations, cytomixis, aneuploidy, high male fertility.

Introduction

Desynapsis is an important cytological phenomenon and is used to denote the falling apart of the synapsed homologues due to their inability to retain or generate chiasmata (Sharp, 1930; Li *et al.*; 1945; Rieger *et al.*, 1976). Riley and Law (1965) however coined the name 'synaptic mutants' as a better alternative to desynapsis. Desynaptic plants offer possibility for the production of aneuploids (Soost, 1951; Burnham, 1962). Both spontaneous and induced types of desynapsis have been reported in different plant species (Koduru & Rao, 1981; Datta & Biswas, 1985; Poddar *et al.*, 1998; Sengupta *et al.*, 1999; Saha & Datta, 2002) including jute (*Corchorus olitorius* -Basak & Paria, 1979) and in most cases they have been governed by gene(s). The present paper describes a naturally occurring desynaptic mutant in *Corchorus fascicularis* Lamk. (Family: Tiliaceae), a wild species of jute (2n=14) which showed high degree of tolerance against stem rot disease caused by *Macrophomina phaseolina* (Palve *et al.,* 2004).

Materials and Methods

The desynaptic plant of *C. fascicularis* – WCIJ 150 (germplasms obtained from CRIJAF, Nilgunj, West Bengal) was spotted in the natural population (1 out of 27 plants) when routine male meiosis was performed in different jute species (Maity & Datta, 2009). Morphology, meiotic chromosome behaviour (PMC squashes were made from microsporophylls and stained in 1% propionocarmine solution) and pollen fertility (fully stained pollens in 1% propionocarmine solution were considered fertile) were studied in the marked desynaptic plant as well as in desynaptic plants recovered from the segregating progenies (cytological data pooled over the desynaptic plants) and compared to normal plants maintained under similar environmental conditions. Desynaptic and normal plants were designated as ds and N respectively in the text. Photomicrographs were taken from temporary squash preparations.

Selfed seeds of the desynaptic plant was sown in subsequent generation and genetic segregation of the desynaptic trait (mutant) was predicted following the application of X^2 -test analysis.

Results and Discussion

The marker plant was bushy, compact and spreading in nature like normal plants but the extent of spreading (from main shoot) was less in ds (8000.73 sq cm) than normal (15412.38 sq cm). Leaf size (5.24±0.6X0.8±0.2 sq cm; N: 6.3±0.2X1.1±0.1sq cm.; t value 2.24 at 18DF, p <0.05) and area (ds: 602.0 sq cm ± 3.4; N: 789.0sq cm.±4.2; t value 7.6 at 18 DF, p < 0.001), flower (ds : 3.4±0.2X0.8±0.1sq mm; N: 4.0±0.1X 1.0±0.1 sq mm; t value 2.89 at 18 DF, p < 0.01) and fruit (length: 2.90cm. ± 0.1, N: 3.30cm ± 0.1, t = 2.28 at 18 DF, p < 0.05; breadth : ds – 2.6 mm ± 0.1, N - 2.76mm ± 0.1, t = 1.4 at 18 DF, p > 0.05, not significant) sizes and seed yield (ds – 2.1 gm ± 0.1, N – 3.1 gm ± 0.1, t value 3.2 at 18 DF, p < 0.01) were significantly lower in ds than normal plants. Further, ds exhibited delayed flowering (45 – 49 days from sowing) compared to normal plants (29 – 35 days from sowing) of *C. fascicularis*. However, stem (greenish brown), leaf (scheeles green - 860) and flower (dull yellow) colours were alike in the plant types. Desynaptic mutants with perceivable morphological changes have been reported earlier (Ehrenberg, 1949; Jones, 1970; Ramalingam, 1977; Datta & Biswas, 1985; Saha & Datta, 2002).

Meiotic chromosome behaviour and pollen fertility of normal and desynaptic plants (Fig. 1-9) were presented in Table 1. Frequency of univalent per cell in desynaptic plants were markedly higher compared to normal plants. Average chromosome association per cell in ds plants were recorded to be 5.12II + 4.05I in comparison to 0.002IV + 6.99II + 0.31I in normal. In the desynaptic plants univalents were marked in close proximity to each other at diplotene and diakinesis (Fig.2-7). Such juxtaposed arrangement of univalents in desynaptic cells represents the residual attraction between homologues and their very recent separation. This also signifies that formation of univalents was just before metaphase I and those univalents at MI usually remain scattered in the spindle more towards the poles (Fig. 3). Person (1955) coined the term 'meta-anaphase' to describe this stage of meiosis. The ds plant showed variable types of

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chromosome associations of which predominant were 7 II (25.70% - Fig. 1), 6II + 2I (18.69 %) and 2II + 10I (18.69 %) formation. Normal plants formed 7II in 65.06% cells. Frequency of chiasma per cell and per bivalent was 6.67 and 0.95 in ds and 7.28 and 1.04 in normal plants respectively. Occurrence of univalents in most of the cells (70.56%) studied at diplotene, diakinesis and MI of the ds plants followed by enhanced univalent frequency per cell with concomitant reduction in chiasma frequency per cell with lower number of bivalents have indicated that desynapsis was 'medium strong type' as per classification proposed by Prakken (1943). Medium strong desynapsis has been reported earlier in different plant species (Sjodin, 1970; vide Koduru & Rao, 1981; Podder *et al*., 1998; Saha & Datta, 2002).

As desynapsis is a mutant trait compared to normal synapsis of homologues in meiocytes, the present desynaptic plant of *C. fascicularis* can be referred to as spontaneous desynaptic mutant. It segregated to a close fit of 3:1 ratio (normal plant 14, desynaptic plant 4, total 18, X^2-value 0.075 at 1 DF, $p < 0.80$) in the self segregating population thereby suggesting that the mutant trait was possibly monogenic recessive to normal. Most desynaptic mutant reported showed monogenic recessive inheritance (vide Koduru & Rao, 1981) and therefore the phenomenon is under gene(s) control.

Anaphase I (AI) distribution of chromosomes in the desynaptic mutant was nearly (84.85%) equal (7/7) thereby suggesting that the univalents formed during the course of meiosis were randomly distributed to their respective poles. Unequal separation (6-1-7 and 5-9) of chromosomes was studied only in 13.64% cells of the mutant. AII cells in both plant types were cytologically balanced (excepting 5.17% meiocytes of the mutant showed 1 to 2 laggard formation). Pollen fertility recorded in normal plants was 92.06% and in mutant was 81.77%. In general, the pollen fertility of desynaptic mutants will be reduced and variable depending on the intensity of mutation. Normal division of univalents at AI followed by restitution at AII possibly restored high fertility in the present desynaptic mutant. Similar findings were also observed in *Allium* (Levan, 1940) and in Paspalum (Christopher, 1971).

Cytomixis (cell to cell migration of chromatin materials) was evident in both plant types at prophase I and metaphase I resulting in the formation of aneuploid (hypo and hyperploidy) PMCs (mutant: n=1,4, 9, 10, 12 and 14; normal: n= 1, 2, 3, 4, 5, 6, 9, 10 and 14). Aneuploidy (Table 1, Fig. 7-9) was predominant in MI (mutant: 4.20%, normal: 24.42%) cells and rarely noted at AI (mutant: 1.52%, normal: 1.79%), thereby suggesting that the abnormal meiocytes formed as the consequence of cytomixis possibly failed to survive beyond certain stage(s) of meiosis.

The desynaptic mutant plants possessing distinctive morphological variations than normal offer scope of easy screening from segregating population, and high fertility associated to them is of utmost importance for their maintenance as true breeding line for further exploitation in the field of cytogenetics.

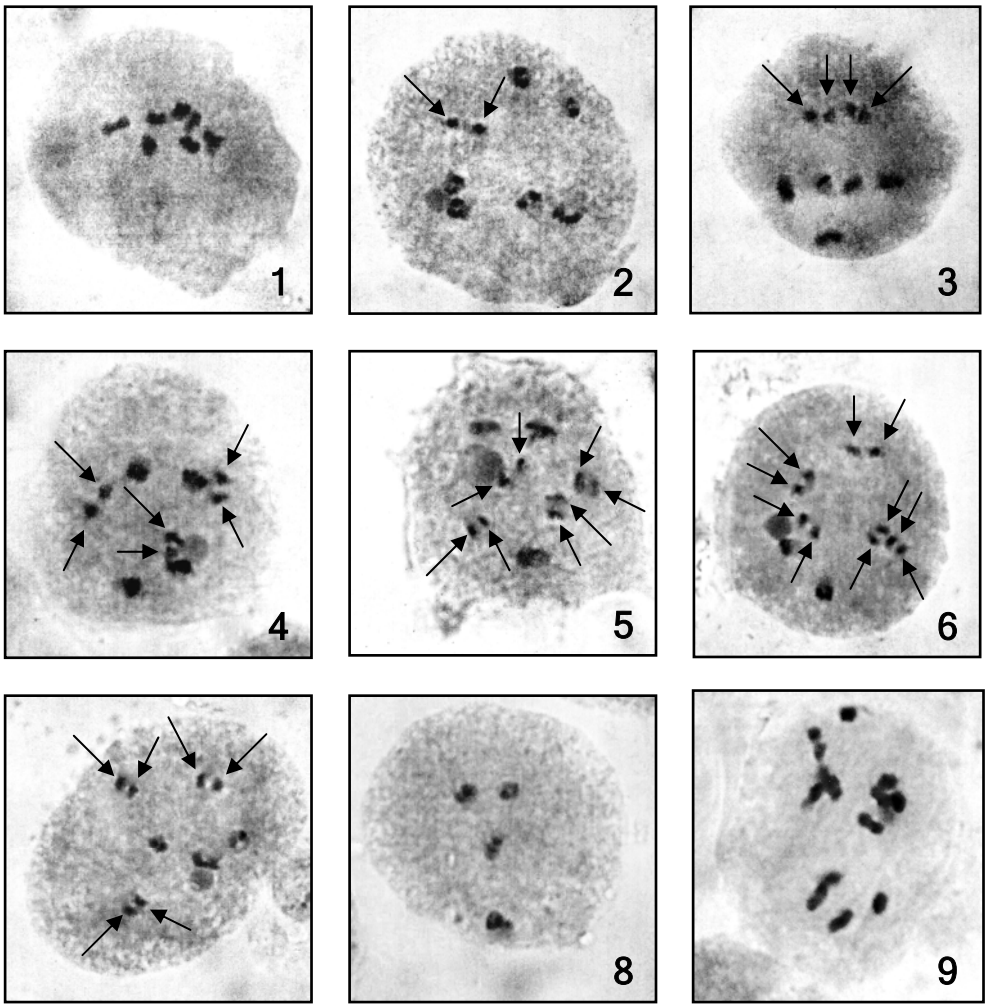

Fig. 1-9. Meiotic configurations at Prophase I (2 and 4-7) and metaphase I (1, 3, 8 & 9) of the desynaptic mutant of C. fascicularis. 1. 7 II. 2. 6II + 2I. 3. 5II + 4I. 4. 4II + 6I. 5. 3II + 8I. 6. 2II + 10I. 7. 3II + 6I (2n = 12). 8. 4II (2n = 8). 9. 14II (2n = 28). Univalents marked by arrow and in prophase I cells nucleolus are evident.

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Table 1. Meiotic configurations and pollen fertility in normal and in the desynaptic mutant of C. fascicularis.

Attributes	Control	Mutant
Prophase I/ Metaphase I associations (%):		
7II	65.06	25.70
6I + 2I	7.95	18.69
5II + 4I	1.70	14.02
4II + 6I	0.85	14.02
3II + 8I	0.00	4.67
2II + 10I	0.00	18.69
1II + 12I	0.00	0.00
14I	0.00	0.00
2n = 14 (%)	75.57	95.79
2n < 14 (%)	14.20	1.40
2n > 14 (%)	10.22	2.80
Bivalent/ cell	6.99	5.12
Univalent/ cell	0.31	4.05
Quadrivalent/ cell	0.002	0.00
Chiasma/ cell	7.28	6.67
Chiasma/ bivalent	1.04	0.95
Total cells scored	352	214
Normal (7/7) AI separation (%)	92.86	84.85
Unequal AI separation (%)	5.36	13.64
Aneuploid AI cell (%)	1.79	1.52
Total AI cells scored	56	66
Normal AII cells (%)	100.00	94.83
Total AII cells scored	78	58
Total no. of pollen assessed	655	826
Pollen fertility (%)	92.06	81.77

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