A NOTE ON THE OCCURRENCE OF DESYNAPSIS IN *CORCHORUS PSEUDO-OLITORIUS* I. AND Z. (TILIACEAE)

Aninda Mandal and Animesh K. Datta*

Department of Botany, Cytogenetics and Plant Breeding Section, Kalyani University, Kalyani – 741235, West Bengal, India
**Corresponding author e-mail: dattaanimesh@gmail.com*

Abstract: Two desynaptic plants of *Corchorus pseudo-olitorius* I. and Z. (Family: Tiliaceae; important genetic resource of Jute) showing no phenotypic variations than standard normal plants were identified from the natural population (2 out of 4 plants; 4 plants germinated from 100 seeds) of *Corchorus* spp. (the wild species are under acclimatization, 3rd year) following male meiotic analysis. Compared to normal plants, the spontaneous desynaptic plants (ds_1: 'weak type'; ds_2: 'medium strong type') demonstrated enhanced univalent frequency per cell, reduced number of chiasma and bivalent per nucleus (ds_1: 5.57II+1.63I/cell- diplotene, 6.38II+1.23I/cell- MI, chiasma 6.93±0.16/cell; ds_2: 4.56II+4.88I/cell- diplotene, 5.06II+3.89I/cell- MI, chiasma 5.41±0.20/cell; normal: 6.81II+0.38I/cell- diplotene, 6.75II+0.25I/cell- MI, chiasma 7.81±0.28/cell). Univalents were randomly distributed at MI irrespective of bivalent frequency in a meiocyte. Although variable chromosomal associations were noted in the plant types (ds_1: 7II to 1II+12I, ds_2: 7II to 14I; normal: 7II to 5II+4I at diplotene, 7II and 5II+4I at MI) 7II formation was the most predominant type. Occurrence of 14I in both diplotene (13.75%) and MI (11.81%) was only recorded in ds_2. Mostly (ds_1: 93.62%, ds_2: 86.84%, normal: 100.00%), AI cells were cytologically (7:7) balanced (rare often unequal distribution like 6:1:7, 7:9 and 5:9 were observed; ds_2 showed failure of cytokinesis- 2.63%). All AII cells were also cytologically normal. Pollen fertility (ds_1: 72.49%, ds_2: 65.35%), viability (ds_1: 72.06%, ds_2: 57.48%) and size (ds_1: 40.78±0.9×30.76±1.5, ds_2: 41.08±0.7×32.23±0.9) and seed set per capsule (ds_1: 88.81±2.1, ds_2: 87.50±1.2) were nearly in accordance to standard normal plants (pollen fertility: 76.48%, pollen viability: 74.48%, pollen size: 40.21±0.1×30.74±0.1, seed set/capsule: 88.02±1.8).

Keywords: *Corchorus pseudo-olitorius*, desynapsis, fertility, spontaneous, weak and medium strong types

INTRODUCTION

The process of meiosis is a programmed genetical event, and is pivotal in understanding reproduction, fertility, genetics and breeding in crop plants (Armstrong and Jones 2003). Alteration in gene(s) involved in meiotic processes, natural or induced, affects cytogenetical consequences. Desynapsis is one such event (better coined as 'synaptic mutants' – Riley and Law 1965) arising out of meiotic cell division due to falling apart of the synapsed homologues (inability to generate or retain chiasmata – Li *et al.* 1945, Reiger *et al.* 1976) and is reported in a large number of plant species of diverse phylogenetic relationship (Koduru and Rao 1981, Datta and Biswas 1985, Poddar *et al.* 1998, Saha and Datta 2002, Jackson *et al.* 2002, Sosnokhina *et al.* 2002, Calisto *et al.* 2008) including *Corchorus* spp. (*C. olitorius* – Basak and Paria 1979, *C. fascicularis* – Maity and Datta 2009). Significance of desynaptic mutants in the production of aneuploids was predicted (Soost 1951, Burnham 1962) apart from possessing profound academic interest. The present paper describes two naturally occurring desynaptic plants (under 3rd year of acclimatization of Jute germplasms) in *C. pseudo-olitorius* I. and Z. (though poor fibre yielder but important genetic resource – highly resistant to stem rot pathogen *Macrophomina phaseolina*, Annual Report, CRIJAF, ICAR, 2008-09) as a part of the project on interspscific hybridization and crop improvement.

MATERIAL AND METHOD

In course of routine male meiotic analysis (PMCs, pollen mother cells and pollen grains obtained from anther squash preparations were stained in 1% propinocarmine solution; fully stained pollen grains were considered fertile as per Marks 1954; pollen viability assessed following stain test: Aniline blue- detects the presence of callose on pollen wall, viable pollen turns blue – Bengtsson 2006) in *Corchorus* spp. (3 to 4 flower buds were fixed from individual plants of each species in Carnoy's fixative for 72 hours and preserved in 70% alcohol), two plants (designated as ds_1 and ds_2 in the text) with desynaptic behavior of chromosomes were spotted in *C. pseudo-olitorius* (accession No. OIN 507, obtained from CRIJAF, Nilganj, West Bengal) from the natural population (4 plants germinated out of 100 seeds in 3rd year of acclimatization in the experimental field plots of Department of Botany, Kalyani University; plants raised during the months of March to October; bud fixation was uniformly performed during July to August). Pollen size, capsule length (first formed 5 capsule) and seeds per capsule were also assessed in the marked plants and in normal plants.

Meiotic data were scored at diplotene, metaphase I (MI) and anaphase I (AI) in both ds_1 and ds_2 as well as in standard normal plants (data pooled over the two plants). Photomicrographs were taken from temporary squash preparation and suitably enlarged.

RESULT AND DISCUSSION

Data analyzed for different chromosomal configurations, pollen fertility, viability and size,

capsule length and seeds per capsule in ds_1 and ds_2 in relation to normal plants are presented in Table 1. Variable chromosomal associations (7II to 1II+12I in ds_1 and 7II to 14I in ds_2) were noted in both diplotene and MI cells of the marked plants (Figs. 1-9); while, standard normal plants formed only 7II (86.15% diplotene; 87.32% MI), 6II+2I (8.46% diplotene) and 5II+4I (5.38% diplotene; 12.68% MI) in their meiocytes. Predominant association in all plant types irrespective of the stage of division was 7II. Formation of 14I was recorded in ds_2 in both diplotene (13.75%) and MI (11.81%) cells (Figs. 6 and 9). Frequency of univalent per cell in the marked plants was much higher compared to normal plants. Mean chromosome association per cell was 5.57II+1.63I at diplotene, 6.38II+1.23I at MI in ds_1, 4.56II+4.88I at diplotene, 5.06II+3.89I at MI in ds_2 and 6.81II+0.38I at diplotene, 6.75II+0.25I at MI in normal plants. In the marked plants, univalents were mostly in close proximity (Figs. 4-5) to each other at diplotene and diakinesis thereby indicating residual attraction between homologues and their very recent separation. At MI, univalents were found to be distributed randomly irrespective of the number of bivalents per cell (Figs. 7-9) thereby corroborating John and Lewis (1965) concerning distribution of univalent in desynaptic plants. However, Östergren and Vigfosson (1953) suggested that orientation of univalents was polar when bivalents were few and equatorial when bivalents were more. In the present investigation occurrence of enhanced univalent frequency per cell with concomitant reduction in chiasma (ds_1: 6.93±0.16/cell; ds_2: 5.41±0.20/cell; normal: 7.81±0.28/cell) frequency at diplotene per cell with lower number of bivalents in the marked plants were indicative of desynapsis, and desynapsis was 'weak– ds_1' and 'medium weak– ds_2' types as per classification proposed by Prakken (1943).

AI distribution (ds_1: 93.62%, ds_2: 86.84% and normal: 100.00%) of chromosomes in desynaptic plants (Fig. 10) was nearly equal (7:7), thereby suggesting that the univalents formed during the course of meiosis were randomly distributed to their respective poles. However, rare often unequal separation of chromosomes (ds_1- 6:1:7- 6.38%; ds_2- 6:1:7- 2.63%, 7:9- 3.95%, 5:9- 3.95%) and failure of cell plate formation at AI (ds_2- 2.63% - Figs. 11-12) were also observed. All analyzable AII cells in desynaptic plants were cytologically balanced. Pollen fertility, viability, size and seed set per plant in the desynaptic plants were at accordance to normal. Normal division of univalents at AI followed by restitution at AII mostly possibly restored high fertility in the present desynaptic plants. Similar such findings were also noted in *Allium* (Levan 1940), *Paspalum* (Christopher 1971) and *C. fascicularis* (Maity and Datta 2009).

CONCLUSION

Though the desynaptic plants were indistinguishable phenotypically from standard normal plants of *C. pseudo-olitorius*, the seed fertile plants may be utilized as genetic resources for understanding gene and chromosome relationship in the species.

ACKNOWLEDGEMENT

The research is grant aided by UGC, India.

Table 1. Cytomorphological and palynological parameters in normal and desynaptic plants.

Attributes	Normal	Desynaptic plants	
		ds_1	ds_2
Diplotene-diakinesis:			
I/cell	0.38	1.63	4.88
II/cell	6.81	5.57	4.56
Mean chiasma/cell	7.81±0.28	6.93±0.16	5.41±0.20
Predominant association- 7II (%)	86.15	50.62	31.25
Total cells scored	130	81	80
Metaphase I:			
I/cell	0.25	1.23	3.89
II/cell	6.75	6.38	5.06
Predominant association- 7II (%)	87.32	64.65	51.18
Total cells scored	71	99	127
No. of AI cells analyzed	88	94	76

Equal (7:7) AI separation of chromosomes (%)	100.00	93.62	86.84
Pollen fertility (%)	76.48 (812)	72.49 (458)	65.35 (791)
Pollen viability (%)	74.48 (580)	72.06 (408)	57.48 (772)
Pollen size (µm)	40.21±0.1× 30.74±0.1	40.78±0.9× 30.76±1.5	41.08±0.7× 32.23±0.9
Capsule length (cm)	3.62±0.1	3.44±0.1	3.50±0.1
Seed/capsule	88.02±1.8	88.81±2.1	87.50±1.2

Values in parenthesis indicate total number of pollen grains studied.

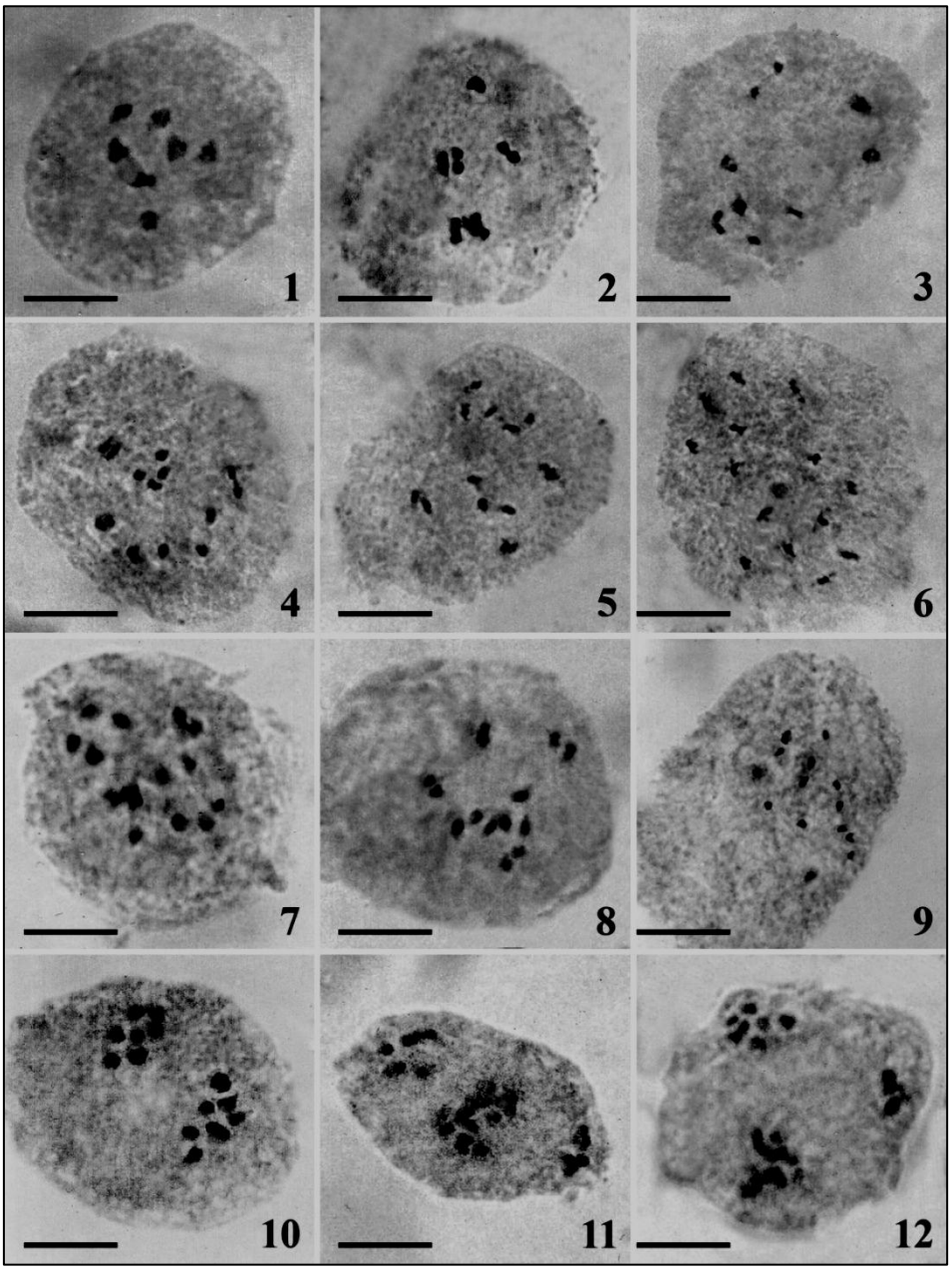

FIGURE LEGENDS

Figure Plate I (1-12) showing meiotic configurations (**1, 3-6:** diplotene; **2, 7-9:** MI; **10-12:** AI) of *C. pseudo-olitorius* **(1-2)** 7II; **(3)** 5II+4I; **(4)** 3II+8I; **(5)** 2II+10I; **(6)** 14I; **(7)** 2II+10I; **(8)** 1II+12I; **(9)** 14I; **(10)** 7:7 separation; **(11-12)** failure of cytokinesis at AI. Scale bar=10 µm.

REFERENCES

Armstrong, S.J. and Jones, G.H. (2003). Meiotic cytology and chromosome behavior in wild type *Arabidopsis thaliana*. *Journal of Experimental Botany*, **54**(380): 1-10.

Anonymous. (2008-09). Annual report 2008-09, CRIJAF, Barrackpore, Kolkata. P. 18.

Basak, S.L. and Paria, P. (1979). Desynapsis and spontaneous trisomy in jute (*Corchorus olitorius* L.). *Theoretical and Applied Genetics*, **56**(6): 253-256.

Bengtsson, S. (2006). Evaluation of transgenic *Campanula carpatica* plants. Dept. of Agricultural Sciences, SLU. Master's project in the Danish-Swedish Horticultural programme. P. 6.

Burnham, C.R. (1962). Discussions in cytogenetics. Burgess Publishing Company, Minneapolis, Minn.

Calisto, V.; Fuzinatto, V.A.; Message, H.J.; Mendes-Bonato,A.B.; Boldrini, K.R.; Pagliarini, M.S. and Valle, C.B.D. (2008). Desynapsis and precocious cytokinesis in *Brachiaria humidicola* (Poaceae) compromise meiotic division. *Journal of Genetics*, **87**(1): 27-31.

Christopher, J. (1971). Asynapsis in *Paspalum* Linn. *Nucleus*, **14**(2): 116-118.

Datta, A.K. and Biswas A.K. (1985). A EMS-induced mutant of *Nigella sativa* L. with desynaptic behavior of chromosomes. *Cytologia*, **50**(3): 535-543.

Jackson, R.C.; Ngo, N. and Ngo, H. (2002). Chromosome-specific desynapsis in the n=2 race of *Haplopappus gracilis* (Compositae). *American Journal of Botany*, **89**(5): 777-782.

John, B. and Lewis K.R. (1965). The Meiotic System. Protoplasmatologia, Bd. VI. Fr. Springer Verlag, Wien, New York.

Koduru, P.R.K. and Rao M.K. (1981). Cytogenetics of synaptic mutants in higher plants. *Theoretical and Applied Genetics*, **59**(4): 197-214.

Levan, A. (1940). The cytology of *Allium amplecteus* and the occurrence in nature of its asynapsis. *Hereditas*, **26:** 353.

Li, H.W.; Pao, W.K. and Li, C.H. (1945). Desynapsis in the common wheat. *American Journal of Botany*, **32**(2): 92-101.

Maity, S. and Datta, A.K. (2009). Spontaneous desynapsis in *Corchorus fascicularis* Lamk. (Family: Tiliaceae) *Indian Journal of Science and Technology*, **2**(3): 34-36.

Marks, G.E. (1954). An aceto-carmine glycerol jelly for use in pollen-fertility counts. *Biotechnic & Histochemistry*, **29**(5): 277-278.

Östergren, G. and Vigfosson, E. (1953). On position correlations of univalents and quasi-bivalents formed by sticky univalents. *Hereditas*, **39**(1-2): 33-50.

Podder, S.; Datta, A.K. and Dana, S. (1998). Cytogenetics of desynaptic mutants in homozygote stock of *Rhoeo spathacea* var. *concolor*. *Nucleus*, **41**(3): 115-119.

Prakken, R. (1943). Studies of asynapsis in rye. *Hereditas*, **29:** 475-495.

Reiger, R.; Michaelis, A. and Green, M.M. (1976). Glossary of Genetics and Cytogenetics, 4th Edn. Berlin, Heidelberg, New York, Springer.

Riley, R. and Law, C.N. (1965). Genetic variation in chromosome pairing. *Advances in Genetics*, **13:** 57-114.

Saha, A. and Datta, A.K. (2002). Synaptic mutants with phenotypic marker trait in Black Cumin (*Nigella sativa* L.). *Plant Archives*, **2:** 147-150.

Soost, R.K. (1951). Comparative cytology and genetics of asynaptic mutants in *Lycopersicon esculentum* L. *Genetics*, **36:** 410-434.

Sosnokhina, S.P.; Kirillova, G.A.; Tikholiz, O.A.; Mikhaĭlova, E.I.; Priiatkina, S.N. and Smirnov, V.G. (2002). Genetic analysis of mutation sy2 which causes nonhomologous meiotic synapsis in chromosomes of diploid rye *Secale cereal* L. *Genetika*, **38**(3)**:** 347-356.