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# Desynapsis and Spontaneous Trisomy in Jute (*Corchorus olitorius* L.)

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**Summary**. Cytological studies in desynaptic plants, isolated at the $F_6$ generation of an intervarietal cross of *Corchorus olitorius* L., have shown variable numbers of bivalents and univalents in the PMC's at metaphase I, resulting in irregular distribution of chromosomes at anaphase I. The progenies of the desynaptic plants consisted of 9.24 percent of all possible primary trisomics except trisomic 6. The desynaptic condition is controlled by a pair of simple recessive genes.

**Key words:** *Corchorus olitorius* – Desynapsis – Trisomics

## Introduction

Meiotic irregularities like asynapsis and desynapsis are useful in producing aneuploids in plants. Following the classic work of Beadle (1930, 1933) on asynapsis in maize, a host of studies in the same line have been reported. As far as jute (*Corchorus olitorius*) is concerned, a spontaneously occurring asynapsis (Mitra and Singh 1971) and a monogenically controlled X-ray induced desynaptic mutant (Paria et al. 1978) have been reported so far. Detailed cytological, genetic and breeding behaviour of naturally occurring desynaptic plants in the same species is reported here.

## Materials and Methods

Desynaptic plants used in this study were isolated at $F_6$ generation of an intervarietal cross between 'Chinsurah Green' and 'Tall mutant' of *Corchorus olitorius*.

Cytological preparations were made after fixing the flower buds in Carnoy's fixative and squashing the anthers in propionocarmine solution. Pollen fertility was examined after staining with propionocarmine. Microphotographs were taken from temporary preparations.

Progenies of open pollinated desynaptic plants were examined for frequencies of different primary trisomics. Trisomics were identified following the descriptions given by Paria and Basak (1979) and cytological confirmation of trisomics was followed. For genetic analysis the desynaptic plants were crossed with normal pairing stocks and segregation of desynapsis was recorded in $F_2$ generation.

## Results

### *Cytological Behaviour*

Pachytene pairing in desynaptic plants was partial to complete (Fig. 1). The chromosomal associations at diakinesis or metaphase I are given in Table 1. Varying numbers of univalents in the PMC's at diakinesis or metaphase I were observed (Figs. 2-5) and on average PMC's contained 12.2 I's + 0.9 II. PMC's with 14 I's were most frequent (47.7 percent). The maximum number of bivalents observed in a PMC was 5. PMC's with increasing numbers of bivalents were observed in decreasing frequencies.

Failure to hold bivalents at diakinesis led to irregular orientation. The different types of anaphase I separations observed are given in Table 2. The chromosomes at meta-

**Table 1.** Association of chromosomes at metaphase I in desynaptic plants

|  | Number | Percentages |
|---|---|---|
| PMC's with |  |  |
| 14 I's | 135 | 47.70 |
| 12 I's + 1 II | 64 | 22.61 |
| 10 I's + 2 II's | 58 | 20.49 |
| 8 I's + 3 II's | 17 | 6.01 |
| 6 I's + 4 II's | 7 | 2.47 |
| 4 I's + 5 II's | 2 | 0.71 |
| Total PMC's observed | 283 |  |

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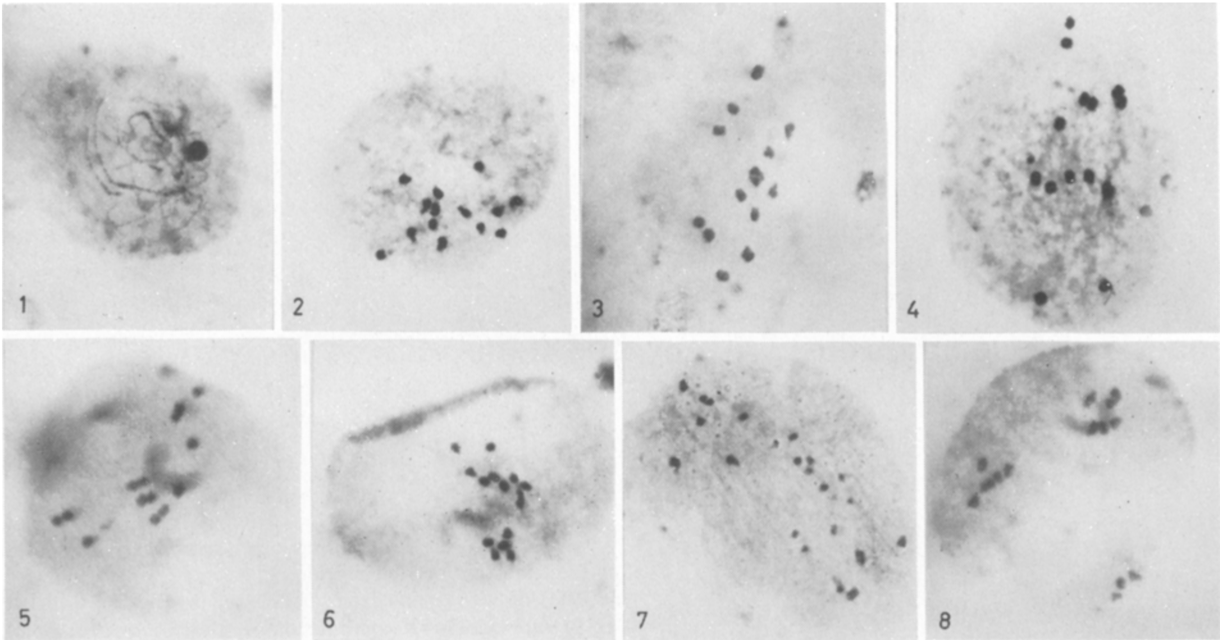

**Figs. 1-8.** **1** PMC at pachytene showing partial pairing; **2** PMC at diakinesis showing 14 I's; **3** PMC at diakinesis showing 1 II and 12 I's; **4** PMC at metaphase I showing 2 II's and 10 I's, two pairs of univalents showing precocious movement; **5** PMC at diakinesis showing 5 II's and 4 I's; **6** PMC at anaphase I showing 5 and 9 chromosomes at opposite poles; **7** PMC at anaphase I showing equational division of univalents; **8** PMC at anaphase I showing tripolar distribution of chromosomes.

phase I moved precociously to the poles resulting in atypical distribution of chromosomes in anaphase I (Figs. 6-8).

Of these unpaired chromosomes at metaphase I, one or two pairs of univalents were found consistently moving to the opposite poles effecting balanced gamete formation for these chromosomes (Fig. 4). In 12.04 per cent of PMC's bipolar distribution with varying numbers of laggards was observed. The lagging univalents usually divided equationally and moved to opposite poles at late anaphase I. Numerically balanced bipolar distribution of the type 7/7 separation and numerically unbalanced bipolar distributions with a range of 12/2 to 8/6 types were observed in varying amounts. The apparently numerically equal separation might have produced normal haploid gametes together with unbalanced gametes such as n + 1-1 because of a lack of precise reductional separation arising from the failure of proper orientation of chromosomes at metaphase I.

**Table 2.** Anaphase I separation in desynaptic plants

| | Number | Percentage |
|---|---|---|
| PMC's showing: | | |
| Multipolar separation | 27 | 14.14 |
| Bipolar separation and laggards | 23 | 12.04 |
| Bipolar separation with unequal chromosomes at poles | 122 | 63.87 |
| Bipolar separation with equal chromosomes at poles | 19 | 9.95 |
| Total PMC's | 191 | |

## *Genetics*

$F_1$'s of the crosses between desynaptic and normal pairing stocks were normal in pairing. Thus normal pairing was completely dominant over desynapsis. The $F_2$ segregation into desynapsis and normal pairing shown in Table 3 clear-

**Table 3.** Segregation of desynapsis in $F_2$ families

| Family | Normal pairing | Desynapsis | Expected ratio | $\chi^2$ | P |
|---|---|---|---|---|---|
| 1 | 604 | 188 | 3 : 1 | 0.6734 | 0.30-0.50 |
| 2 | 411 | 144 | 3 : 1 | 0.2648 | 0.50-0.70 |
| 3 | 182 | 58 | 3 : 1 | 0.1172 | 0.70-0.80 |
| 4 | 131 | 45 | 3 : 1 | 0.0303 | 0.80-0.90 |
| 5 | 242 | 91 | 3 : 1 | 0.9619 | 0.30-0.50 |
| 6 | 121 | 43 | 3 : 1 | 0.1301 | 0.70-0.80 |
| 7 | 294 | 87 | 3 : 1 | 0.9527 | 0.30-0.50 |
| Total | 1985 | 656 | 3 : 1 | 0.0364 | 0.70-0.80 |
| Heterogeneity | | | | 3.0940 | 0.70-0.80 |

ly shows that desynapsis is conditioned by a recessive gene and the gene symbol, as proposed for artificially induced desynapsis (Paria et al. 1978) can be ratained for the present case.

### *Breeding Behaviour*

Though the desynaptic plants and their normal sibs started flowering simultaneously, the former continued flowering for unusually long period and started setting pods when the latter had completed their life cycle. Thus the desynaptic plants were reproductively isolated from their normal sibs.

The leaves of desynaptic plants emerging after the flower initiation were much smaller than the normal ones. These smaller leaves facilitated identification of desynaptic plants towards the end of the growing season. Because of the inefficient reproductive system, compensatory vegetative growth of desynaptic plants continued, giving a more vigorous look in comparison with their normal sibs. Table 4 shows pollen fertility, pod characters and seed fertility in normal and desynaptic plants. The pollen fertility was much lower than in normal plants. The pods of the desynaptic plants were strikingly smaller than those of normal ones and contained much lower numbers of seeds.

Progenies of open pollinated desynaptic plants consisted of diploids and primary trisomics. Aneuploids other than trisomics were not observed. It can be seen from Table 5 that the percentage of trisomics was 9.24 out of total progenies of 1266. Trisomic 7 was the most frequent (35.04 percent), the trisomic 3 was the least frequent and the trisomic 6 was altogether absent.

## Discussion

The origin of desynapsis in $F_6$ generation of a particular type of an intervarietal cross of *C. olitorius* may be traced back to the genotypic constitution of the varieties involved. One of the parents of this cross was 'Tall mutant', which was an X-ray derivative, so it was not unlikely that an induced desynaptic gene remained in heterozygous condition in this variety. On hybridization and selfing a homozygous recessive appeared in later generations. But how the heterozygosity was perpetuated in a self pollinated variety is difficult to explain. Alternatively, the presence of a mutable system in 'Tall mutant' inducing the present mutant can not be ruled out, though no evidence can be put forward. The simplest and the acceptable explanation would, however, be to assume that the desynaptic plants arose from spontaneous mutation of the haplo sufficient normal pairing locus in the later generation.

**Table 4.** Pollen fertility, pod characters, and seed fertility in normal and desynaptic plants

| | Desynaptic plant | | Normal plant | |
|---|---|---|---|---|
| | Range | Mean | Range | Mean |
| Pollen fertility (%) | 0 -18.2 | 3.6 | | 95.8 |
| Pod length (cm) | 0.6- 3.0 | 1.3 | 3.8- 6.5 | 5.3 |
| Number of seeds | | | | |
| Per pod | 0 -35 | 9.9 | 77 -210 | 151.9 |
| Seed fertility (%) | 25.0-89.5 | 77.5 | 62.4- 97.6 | 91.1 |

There has been a large literature on asynapsis and desynapsis in many plant species including maize (Beadle 1930, 1933), *Datura* (Bergner et al. 1934), *Crepis* (Richardson 1935), *Nicotiana* (Goodspeed and Avery 1939) and wheat (Huskins and Hearne 1933). Monogenic recessive condition controlling desynapsis in the present case was found to be characterized by fairly complete to loss of pachytene pairing, leading to early separation of bivalents at diplotene and diakinesis resulting in variable numbers of univalents and bivalents at metaphase I. The observed variation in the extent of pachytene pairing and in the frequencies of bivalents in PMC's may very well be attributed to the variable expressivity of the desynaptic gene, as observed in wheat (Li et al. 1945). Variable number of univalents at diakinesis led to a failure of precise orientation of chromosomes at metaphase I, so affecting the regular distribution of chromosomes at anaphase I. Irregular distribution of chromosomes at anaphase I in desynaptic plants was expected to have produced a large amount of unbalanced and aneuploid gametes, obviously affecting pollen fertility adversely.

The present study indicates that progenies of desynaptic plants were good sources of all possible primary trisomics except trisomic 6. This is due mainly to irregular distribution of chromosomes at anaphase I producing aneuploid gametes as the source of trisomic zygotes. Earlier, Paria

**Table 5.** Frequencies of primary trisomics in the progeny of desynaptic plant

| | Number | Percentage |
|---|---|---|
| Diploid | 1149 | 90.76 |
| Trisomic (total) | 117 | 9.24 |
| Trisomic 1 | 16 | 13.67 |
| Trisomic 2 | 14 | 11.97 |
| Trisomic 3 | 8 | 6.84 |
| Trisomic 4 | 23 | 19.66 |
| Trisomic 5 | 15 | 12.82 |
| Trisomic 6 | 0 | – |
| Trisomic 7 | 41 | 35.04 |
| Total plants observed | 1266 | |

and Basak (1979) confirmed in the same species that among the aneuploid gametes, n + 1 gametes were the most effective in fertilization. Hence, the absence of aneuploids other than trisomics in the progenies of desynaptics may be justified accordingly. In wheat (Li et al. 1945) and soybean (Palmer 1974) desynaptic plants were found to produce different aneuploids including trisomics. The relative frequencies of different trisomics other than trisomic 6 in the progenics of desynaptic *C. olitorius* approximately correspond to what has been observed by Paria and Basak (1979) in the progenies of autotriploids, either selfed or intercrossed to diploids. The reason for the absence of trisomic 6 in the present case was not clear. One of the possibilities might be the seedling weakness of trisomic 6, which through competition got eliminated. But this was not tenable since this trisomic derived from other sources was as vigorous as the disomics and the frequency was always higher than that of the trisomic 3, which incidentally was the weakest among the trisomics (Paria and Basak 1979). Alternatively, it was quite possible that one, or one of the two pairs of univalents found to move consistently precociously to the poles resulting in production of balanced gametes as far as this chromosome was concerned, was chromosome 6 and thus these plants did not produce trisomic 6 in their progenies. Perhaps the behaviour of chromosome 6 was typical of the genetic background of the trisomic producing desynaptic plants and was unaffected by the disturbance in meiotic drive caused by desynapsis.

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