Cytology of Tetrasomic *Brassica campestris* ($2n=20+2$)

(Miss.) T. Kamala

Andhra University, Waltair, India

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A tetrasomic plant has been located from the progenies of an autotriploid *B. campestris* ($3n=30$). Since no reports on tetrasomics in any of the three elemental *Brassica* species with 'a', 'b' or 'c' genomes are recorded and investigated so far the cytology of this plant has been studied and the results are presented in this paper.

Materials and methods

Fixation of flower buds for meiotic studies are made in field between 10 a.m. and 11 a.m. A fresh mixture of 1:3 acetic acid absolute alcohol is used as the fixative and 1% iron acetocarmine as the staining agent for the meiotic chromosomes. Camera lucida drawings were made at bench level from fresh preparations using 15 $\times$ and 100 $\times$ combinations of lenses in oil.

Results

Chromosome associations at diakinesis were analysed from a total of 30 nuclei (Table 1). The trivalents observed in 15% of the nuclei conformed to the 8th and the 9th types of Darlington (1932, p. 124). Analysis of a few nuclei at midpachytene

Table 1. Distribution of chromosomes at diakinesis

Types of chromosome associations				No. of P.M. Cells
IV	III	II	I	
0	1	9	1	5
0	0	11	0	3
0	0	10	2	21
0	0	9	4	1
Total number of cells studied:				30

revealed that the plant is tetrasomic for chromosome 8 which is a short sub-terminal nucleolus organiser. This chromosome was designated as type A_2 in the complement of *B. campestris* analysed in this laboratory (Venkateswarlu and Kamala 1971). This chromosome is 30 μ in total length with a short arm of 4.0 μ formed by a proximal heterochromatic segment of 1 μ , a middle euchromatic segment of 1 μ and a distal heterochromatic satellite of 2 μ which attaches itself to the nucleolus. The long arm measures 25 μ and comprises a proximal heterochromatic segment of 1 μ

Table 2. Distribution of chromosomes at anaphase I

11-11	12-10	9-13	10 _{II} +2*	11 _I :1*	10 _I +2*	Total
25 (41.6%)	28 (46.6%)	1 (1.6%)	3 (5%)	3 (5%)		60

* half univalents.

Table 3. Distribution of chromosomes at telophase II

10:12-10:12	11:11-11:11	Total	P. M. Cells
25 (62.5%)	15 (37.5%)		40

1a

1b

2a

2b

Figs. 1-2. 1a, association of four of chromosome 8 at midpachytene of *B. campestris*. $\times 1000$. 1b, arrow mark indicates centromere. 2a, diakinesis with 10_{II} and 2_I. $\times 1000$. 2b, figures are drawn to the same size without reduction.

long, and a distal euchromatic segment of 24μ long. (Fig. 1). The four homologues of this chromosome formed an association of four as observed in a few nuclei at midpachytene (Fig. 2). Although there is association at the heterochromatic centromeric regions including the satellite, the euchromatic segments show a 2/2 association throughout their length.

A minimum of 30 associations of three and four homologous chromosomes of this chromosome were analysed in autotriploid and autotetraploid *B. campestris*

respectively in this laboratory (unpublished). A maximum of 4 exchanges were observed in the long arm alone of this chromosome in both the $3n$ and $4n$ plants. Neither exchanges of partners nor chiasmata could be located in the short arm of this chromosome during the course of this analysis. Tables 2 and 3 show chromosome disjunction at anaphase I and II respectively.

Discussion

The trivalent types encountered at diakinesis conformed to the 8th and 9th types of Darlington (1932, p. 124). These two associations require at least one exchange in the long arm with 2 chiasmata in one arm and one chiasma in the other. Although exchanges of partners or chiasmata could not be located in the short arm from the pachytene associations of chromosome 8 analysed in $3n$ and $4n$ *B. campestris* the occurrence of the 9th type of trivalent at diakinesis in the tetrasomic shows that in addition to the occurrence of a single exchange and 2 chiasmata in the long arm there should be a minimum of one chiasma in the short arm also. The absence of this chiasma on the short arm results in the 8th type of trivalent. Although delayed disjunction of the extra chromosomes is observed at anaphase I in one case they passed regularly to the poles in a majority of the nuclei and in a few instances they divided into half univalents and each of these passed to a separate pole. The total number of chromosomes at telophase-II never exceeded the number 44 and the absence of micronuclei, triads or pentads suggests that meiosis is more or less regular.

Summary

The cytology of a tetrasomic *B. campestris* ($2n=20+2$) located in the progeny of autotriploid *B. campestris* ($3n=30$) is described. The chromosome involved in tetrasomy is identified at midpachytene as chromosome 8 which is also the nucleolus organising chromosome with subterminal centromere. This forms type A_2 in the complement of *B. campestris* ($2n=20$) (Venkateswarlu and Kamala 1971). The maximum type of chromosome association observed at diakinesis is a trivalent of the 8th and the 9th types.

Chromosome disjunction at anaphase I and II is more or less regular and meiosis is normal.

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References

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