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The Structural and Numerical Alteratians of Chromosomes in *Brassica campestris* L.

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Brassica campestris L. is known as Indian rape, an important oil seed crop. The species is subdivided into three varieties: i) *B. campestris* var. *toria* Duth. and Full., ii) *B. campestris* var. *sarson* Prain and iii) *B. campestris* var. *dichotoma* Watt. Cytogenetical problems in *B. oleracea* L. have been studied by Howard (1939), Mukherjee (1974).

A detailed cytological analysis involving the study of karyotype with the aid of improved methods as well as the meiotic behaviour taken in conjunction, has not yet been carried out in this species. This is specially necessary in this oil seed crop as in India a large number of strains have been raised in cultivation. In recent years, in several of the agricultural crops such as species of *Hordeum* (Sharma 1956, Sharma and Mukherjee 1956), *Sorghum* (Sharma and Bhattacharyya 1957), *Secale* (Bose 1956) and *Oryza* (Mukherjee and Mukherji 1974), evidences have been brought forward suggesting the role of structural alterations of chromosomes in the evolution of different strains. The present paper deals with the karyomorphological studies of different varieties and strains of *B. campestris* L. with improved technique in order to study the intervarietal and interstrain differences and the role of minute structural and numerical alterations of chromosomes in the evolution of different varieties and strains of *B. campestris*.

Materials and methods

The materials for the present investigation had been obtained through the courtesy of the State Oil Seed Research Station at Berhampore, West Bengal and two strains of *B. campestris* var. *sarson* were collected fom the Faculty of Agriculture at the University of Kalyani. One strains of *B. campestris* var. *toria* collected from the local cultivators of Arambagh, Calcutta suburb. The following materials were included in the present investigation:

1. *Brassica campestris* L. var. *dichotoma*
   (i) B. S. Lotani 13, (ii) B. S. T_{32}, (iii) B. S. T_{65}, (iv) B. S. T_{27}.
2. *B. campestris* L. var. *sarson*
   (i) Y. S. T_9, (ii) Y. S. 151, (iii) Y. S. T_{21}, (iv) Y. S. T_{42}, (v) Y. S. T_5, (vi) Y. S. T_9.
3. *B. campestris* L. var. *toria*
   (i) Toria T_{11}, (ii) Toria T_{86}, (iii) Toria T_{97}, (iv) Toria T_{98}, (v) Toria T_{102}, (vi)

Toria T_{54}, (vii) Toria T_{18}, (viii) Toria T_{81}, (ix) Toria T_{97} and (x) Local cultivated strain.

For somatic study, the seeds were germinated on moist filter paper in Petridishes. Healthy root-tips were selected and pretreated in aq. aesculine solution at 8°C to 10°C (Sharma and Sarkar 1955) for 2 hours 30 minutes and next fixed in propionic alcohol 1:2 for 30 minutes. After fixation, the root-tips were kept in 45% propionic acid for 5 minutes and then propiono-orcein staining technique was followed. For meiotic study, the flower-buds were fixed in propionic alcohol (1:2) and then stored in 70% ethyl alcohol and next smeared in 1% propiono carmine solution. Figures were drawn at a table magnification of ×3000 using Zeiss compensating eye piece ×20 for somatic study and ×15 for meiotic study. Chromosomes with secondary constrictions have been drawn in outline in the somatic plates.

Observations

The somatic chromosome number of three varieties and different strains of *Brassica campestris* is observed as $2n=20$. Deviation in the normal number of chromosome as $2n=18$ within the different strains of the varieties has also been noticed. On the basis of their gross morphological characters, a number of chromosomes seem to be common to all of them. A critical analysis shows that they differ from one another in the minor alterations in the representatives of the types and in different combinations of these types as well. A general description of the types is given below:

Type A — Long chromosome with two constrictions, primary and secondary, one nearly median, and the other nearly subterminal at the distal end of the one of the arms.

Type A′— Long to medium sized chromosome, with nearly median primary constriction and a satellite at the distal end of one of the arms. In some cases the satellite splits into two.

Type B— Comparatively long to medium sized chromosome with two constrictions—primary and secondary, one nearly submedian in position and the other located in the middle of the longer arm dividing the chromosome into three more or less equal segments.

Type C— Comparatively long to medium sized chromosome with median to submedian primary constriction.

Type D— Short chromosome with median to submedian primary constriction.

1. *Brassica campestris* L. var. *dichotoma*

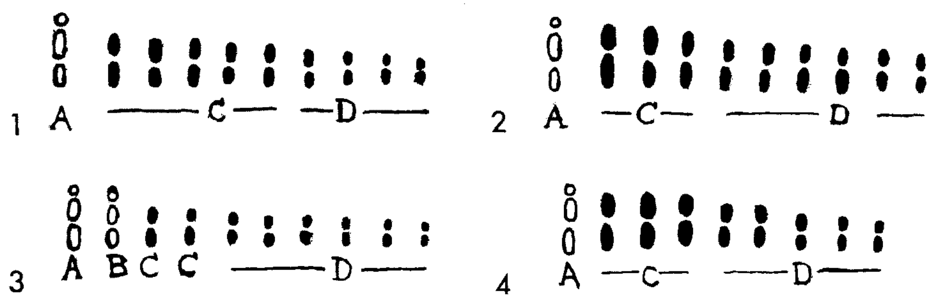
A detailed karyotypic study of five strains of *B. campestris* var. *dichotoma* show a similarity in the chromosome numer being $2n=20$ and morphology. One of the strains B. S. T_{27} shows $2n=18$ and 9 bivalents in meiosis. The strains differ from each other in the minute alterations in the representatives of the above mentioned types and their different combinations as follows:

I) B. S. Lotani 13:—$2n=20=A_2+C_{10}+D_8=3.8\mu-1.8\mu$ (Fig. 1) Meiotic analysis shows 10 bivalents in metaphase I.

II) B. S. T_{32}:—$2n=20=A_2+C_6+D_{12}=3.6\mu\text{–}2\mu$ (Fig. 2) Meiotic analysis shows 10 bivralents in metaphase I.

III) B. S. T_{65}:—$2n=20=A_2+B_2+C_4+D_{12}=3.2\mu\text{–}1.5\mu$ (Fig. 3) Meiotic analysis shows 10 bivalents in metaphase I.

IV) B. S. T_{27}:—$2n=18=A_2+C_6+D_{10}=3.8\mu\text{–}1.5\mu$ (Fig. 4) Meiotic analysis reveals 9 bivalents in metaphase I.

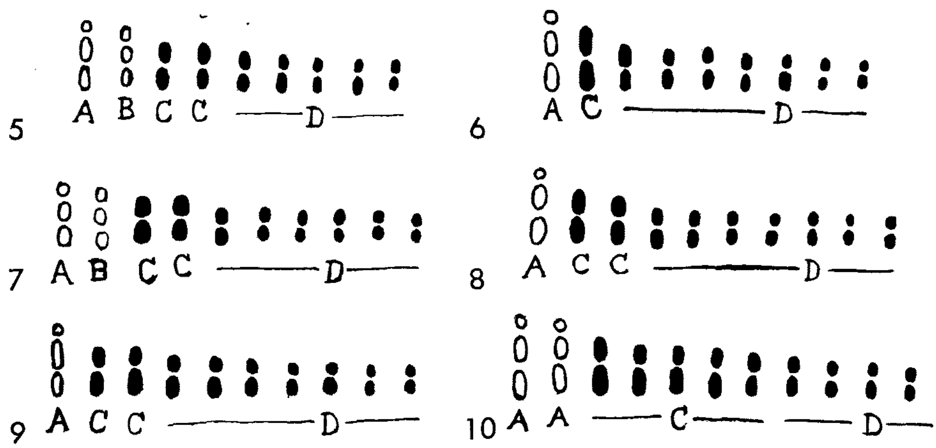


Figs. 1, 2, 3 and 4. Idiograms of the strains. B. S. Lotani 13, B.S. T_{32}, B.S. T_{65} and B.S. T_{27} of *B. campestris* var. *brown sarson*, showing 2n=20, 20, 20 and 18 chromosomes respectively. ×3000.

2. *Brassica campestris* L. var. *sarson*

Most of the strains of *sarson* studied are similar in chromosome number (2n=20) and morphology. Several strains show also 2n=18 or 2n=22 chromosomes. The following combinations of the above types are observed in different strains of *B. campestris* var. *sasron.*

I) Y. S. T_9:—$2=18=A_2+B_2+C_4+D_{10}=3\mu\text{–}2\mu$ (Fig. 5) Meiosis shows 9 bivalents in metaphase I.



Figs. 5, 6, 7, 8, 9 and 10. Idiograms of the strains. Y.S. T_9, Y.S. 151, Y.S. T_{21}, Y.S. T_{42}, Y.S. T_5 and Y.S. 9y of *B. campestris* var. *sarson,* showing 2n=18, 18, 20, 20, 20 and 22 chromosomes respectively. ×3000.

II) Y. S. 151:—$2n=18=A_2+C_2+D_{14}=3.8\mu$–$1.8\mu$ (Fig. 6) Meiosis shows 9 bivalents in diakinesis.

III) Y. S. T_{21}:—$2n=20=A_2+B_2+C_4+D_{12}=3\mu$–$1.7\mu$ (Fig. 7) 10 bivalents are observed in metaphase I.

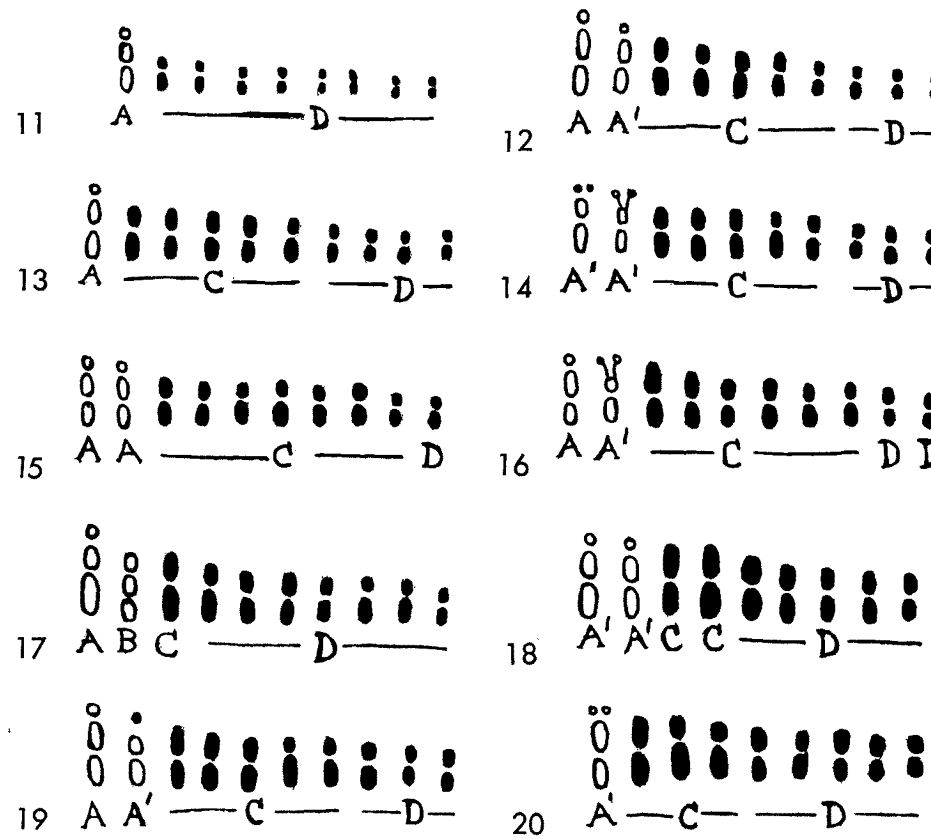
IV) Y. S. T_{42}:—$2n=20=A_2+C_4+D_{14}=3.6\mu$–$1.6\mu$ (Fig. 7) Meiotic study shows 10 bivalents in metaphase I.

V) Y. S. T_5:—$2n=20=A'_2+C_4+D_{14}=3.5\mu$–$2\mu$ (Fig. 9) Meiotic study reveals 10 chromosomes in second metaphase.

VI) Y. S. 9y:—$2n=22=A_4+C_{10}+D_8=3.8\mu$–$2.2\mu$ (Fig. 10) Meiosis reveals 11bivalents in diakinesis.

3. *Brassica campestris* var. *toria*

Chromosome study of ten different strains of *toria* show a similarity in chromosome number (2n=20) and morphology. Several strains show also 2n=18 and 9 bivalents in meiosis. They differ from one another in the different combinations of the representatives of the types as follows:



Figs. 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20. Idiograms of the strains Toria T_{11}, Toria T_{86}, Toria T_{97}, Toria T_{98}, Toria T_{102}, Toria B_{54}, Toria T_{18}, Toria T_{81}, Toria T_{67} and local cultivated strain of *B. campestris* var. *toria*, showing 2n=18, 20, 20, 20, 20, 20, 20, 18, 20 and 18 chromosomes respectively. ×3000.

I) Toria T_{11}:—$2n=18=A_2+D_{16}=3.2\mu-1.3\mu$ (Fig. 11) Meiotic analysis shows 9 bivalents in metaphase I.

II) Toria T_{86}:—$2n=20=A_2+A'_2+C_{10}+D_6=3.5\mu-1.6\mu$ (Fig. 12) Meiotic study reveals 10 bivalents in metaphase I.

III) Toria T_{97}:—$2n=20=A_2+C_{10}+D_8=3.6\mu-1.6\mu$ (Fig. 13) 10 bivalents are observed in metaphase I.

IV) Toria T_{98}:—$2n=20=A'_4+C_{10}+D_6=3.5\mu-1.8\mu$ (Fig. 14) In meiotic study 10 bivalents are observed in metaphase II.

V) Toria T_{102}:—$2n=20=A_2+A'_2+C_{14}+D_2=3.5\mu-2\mu$ (Fig. 15) Meiotic analysis shows 10 bivalents in metaphase I.

VI) Toria B_{54}:—$2n=20=A_2+A'_2+C_{12}+D_4=3.5\mu-1.8\mu$ (Fig. 16) Meiotic analysis shows 10 bivalents in metaphase I.

VII) Toria T_{18}:—$2n=20=A_2+B_2+C_2+D_{14}=4.3\mu-2\mu$ (Fig. 17) Meiotic analysis shows 10 bivalents in diakinesis.

VIII) Toria T_{81}:—$2n=18=A'_4+C_4+D_{10}=4.5\mu-2.5\mu$ (Fig. 18) Meiotic analysis shows 9 bivalents in diakinesis.

IX) Toria T_{67}:—$2n=20=A_2+A'_2+C_{10}+D_6=3.8\mu-2\mu$ (Fig. 19) Meiotic study shows 10 bivalents in metaphase I.

X) Local cultivated strain:—$2n=18=A'_2+C_6+D_{10}=3.5\mu-2.2\mu$ (Fig. 20) Meiosis shows 9 bivalents in metaphase I.

Discussion

In present investigation, five different strains of *B. campestris* L. var. *dichotoma* have been studied. In all of them excepting strain T_{27}, $2n=20$ chromosomes have been observed. The usual chromosome number of *B. campestris* is $2n=20$ (U. 1935). In the strain T_{27}, $2n=18$ chromosomes are noticed. $2n=18$ chromosome is rather unusual for *B. campestris*, though the same number has been reported in several other species of *Brassica*, such as, *B. oleracea* (Howard 1939). Similarly in *B. campestris* var. *sarson* of which six strains were studied, three have shown $2n=20$, two $2n=18$ and one $2n=22$. This last number is no doubt unusual for *B. campestris* and has been reported for one species of *Brassica* viz. *B. elongata* (Manton 1932). The presence of $2n=18$ chromosomes in two strains of *B. campestris* var. *sarson* Y. S. 151 and Y. S. T_9 indicates the evidence of aneuploidy at an intraspecific level. Of the same species var. *toria* some different strains have been studied and $2n=18$ chromosomes have also been noticed in three different strains viz. *Toria* T_{11}, *Toria* T_{81} and one local cultivated strains. Such a wide variation within the same species is a good example of intraspecific evolution, where numerical alterations of chromosomes played an effective part. This intraspecific variation with different chromosome numbers had already been reported by Mukherjee (1971).

Therefore, a study of so many strains of different varieties of *B. campestris* made during present investigation suggests that even within the same variety, the chromosome number may vary in different strains. Such interstrain difference in chromosome number taken in conjunction within fact, that difference in chromosome number within different species should not be regarded as an indication of non-relationship. On the other hand, the possiblity of their origin from a common genome is further substantiated. Such a genome might have six chromosome types in the basic set as suggested by Howard (1939), Mukherjee (1974).

The general similarity in chromosome morphology, consisting mainly of medium sized chromosomes which are mostly medianly constricted and with one or two secondary constrictions indicates that all the different strains are allied to each other. However, regarding the basic number in the karyotype, the strains even within different varieties of *Brassica campestris* L. differ with respect to minute details in chromosome morphology. These facts indicate that even at an intraspecific level minute alterations of chromosomes have been associated in the origin of new strains. Such interstrain difference in karyotype had been reported in *Iberis* (Mukherjee 1973) and also in other species of *Brassica* viz. *B. oleracea* (Mukherjee 1974) and *B. juncea* (Mukherjee 1975).

Summary

Karyomorphological studies of different cultivated strains of three varieties of *Brassica campestris* L. viz. I) *B. campestris* var. *dichotoma*, II) *B. campestris* var. *sarson* and III) *B. campestris* var. *toria* obtained through the courtesy of State Oil Seed Research Station, Berhampore, West Bengal have been studied. Most of the strains show the normal chromosome number as 2n=20 and 10 bivalents in meiosis but several strains viz. I) B. S. B_{27}, II) Y. S. T_9, III) Y. S. 151, IV) Toria T_{11}, V) Toria T_{81} and one local cultivated strains of *toria* show the aneuploid number as 2n=18 chromosomes. Such interstrain difference in chromosome number suggests the role of numerical alterations in chromosomes in the evolution of different varieties and strains of *B. campestris*. Intraspecific variation has been taken to show that difference in chromosome number within difference species should not be regarded as an indication of non-relationship and also confirms the possibility of their origin from a common genome. The role of minute structural alterations of chromosomes has been discussed.

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