Spontaneous Multiple Translocations in *Capsicum annuum* L.

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Spontaneous chromosome translocations apparently identical with those produced by irradiation have been reported in, pea (Hakansson 1929), *Oenothera* (Cleveland 1936), *Tradescantia* (Giles 1940), *Lilium* (Haga 1943), *Melandrium* (Chaudhari 1968), and wheat (Baker and McIntosh 1966 and Narkhede 1979). The effect of translocation is seen when the chromosomes show peculiar types of configuration. Belling and Blakeslee (1924) have shown that by translocation involving two or more chromosomes, chromosome rings are formed in meiosis.

The present paper reports the cytological behaviour of spontaneously induced multiple translocations in chilli plant isolated from the normal population of CA-960 cultivar.

Material and methods

The plant studied was isolated from the normal population of chilli C.V.CA-960, in Kharif 1978. The plant was vigorously growing with broad green leaves. Flowers were big in size as compared to normal plant. The pollen sterility ranged from 90-100%. All these observations created interest to know the cytological behaviour of this plant at meiotic division.

The chromosome behaviour was studied from the anther smears of flower buds fixed in acetic-alcohol, (1:3) solution. 1% acetocarmine stain with ferric acetate was used to increase the stainability of chromosomes. The microphotographs were taken with Olympus PM-6 camera before slides were made permanent. The pollen fertility was scored in 1% aceto-orcein stain.

Results

The chromosome number in normal plant was invariably found to be $n=12$. The same chromosome number was found in the plant under study. But the pairing relationship among the chromosomes was found far different from the normal plant. The results on chromosome association at metaphase I are given in Table 1. Varying types of chromosome configurations were observed which included rings of four chromosomes and 8 chromosomes and chains of four, six, eight, ten, twelve chromosomes and even eighteen chromosomes in rare cases. At metaphase I, 100 PMCs were studied out of which 35 PMCs showed 3 $\odot$ 8 chromosomes each (Fig. 1). Three chains, each of twelve, eight and four chromosomes respectively

Figs 1-8. 1, shows three rings of eight chromosomes each. 2, shows 3 chains of four chromosomes each, one chain of eight chromosomes and two bivalents. 3, shows three chains each of 12, 8 and 4 chromosomes. 4, shows a chain of eighteen and the chain of 6 chromosomes. 5, shows a ring of four chromosomes three chains of 4 chromosomes each, two bivalents and four univalents. 6, shows all univalents. 7, shows rings of chromosomes at both the poles in anaphase I. 8, shows laggards at anaphase I.

were observed in 15 microsporocytes (Fig. 2), whereas 25 pollen mother cells showed 3 chains each of 4 chromosomes, one chain of 8 chromosomes and two bivalents (Fig. 3). Fifteen microsporocytes showed chains of 18 chromosomes and 6 chromosomes respectively (Fig. 4). Five PMCs contained a ring of four chromosomes,

three chains of 4 chromosomes each, 2 bivalents and 4 univalents (Fig. 5). Three percent PMCs showed all chromosomes in the form of univalents (Fig. 6), while only 2% PMCs showed 12 bivalents.

At anaphase I, very irregular distribution of chromosomes was observed. The type of distribution observed at anaphase I is given in Table 2. From this table, it is observed that the chromosomes in the form of ring did not show any disjunction in most of the PMCs studied and the rings as such could be observed at either poles (Fig. 7). Laggards ranging from 9 to 11 were observed in 60% of the cells studied (Fig. 8). At tetrad stage many variations like diad, triad, tetrad and pentads with micronuclei were noted.

Table 1. Pairing association at metaphase I

Sr. no.	Association of chromosomes	No. of PMCs observed
1.	Three rings of 8 chromosomes	35
2.	Three chains of 12, 8 and 4 chromosomes	15
3.	Three chains of 4, chain of 8 and 2 ₁₁	25
4.	Chain of 18 and a chain of 6	15
5.	⊙ 4, 3 chains of 4 chromosomes + 2 ₁₁ + 4 ₁	5
6.	All univalents	3
7.	All bivalents	2

Table 2. Type of disjunction at anaphase I

Type of disjunction	No. of PMCs	observed
1.	Regular	2
2.	Laggards	60
3.	Non-disjunction of rings	30
4.	Chromatin bridges	5
5.	Unequal distribution	3

Discussion

Various types of association among the chromosomes like rings of four and eight chromosomes and chains of 4 to 18 chromosomes and also the bivalents and univalents were observed at metaphase I. The results of such type of pairing can be easily explained if the presence of multiple translocations is assumed. Rings are found when the interchanged parts of chromosomes are long and crossover occurred in each of the arms of chromosomes present (Burnham 1956). If the chiasmata are not formed in all the arms of chromosomes, chains instead of rings are produced. The chains of 'vertical' and 'V' shaped types were observed in the present investigation. Similar types of observations have been made by Sarkar (1955) in grasshopper. When the interchanged segments are very small this may attribute to the formation of bivalents.

The presence of chromosomes of unequal length in the multivalent configurations at meiosis may be an indication that translocation has occurred. Darlington (1929) observed in *Zebrina pendula*, two rings of four chromosomes each, which

were of unequal length. Similarly Meurman (1929 and 1950) and Erlanson (1931) also observed the association of 4, 6, and 8 chromosomes in *Aucuba japonica* ($2n=32$) and 5, 6 and 8 chromosomes association in *Rosa rectia* respectively. In the present investigation unequal sizes of rings were observed.

At anaphase I irregular distribution of chromosomes, laggards and chromatin bridges were observed. Non-disjunction of the chromosomes was more frequent in rings with non-terminal chiasmata at metaphase I. Gairdner and Darlington (1931) also noted such behaviour of chromosomes in *Campanula*. Darlington and Gairdner (1937) stated that the absence of terminalization prevents regular zigzag orientation of the chromosomes in multiple rings. They suggested that the segregation is the result of two forces a) repulsion between the two forces and the associated chromosomes b) repulsion between the paired chromosomes probably localized at the centromere. The latter was supposed to act more strongly along the axis of spindle to repel adjacent chromosomes in the rings and to orient on opposite side of equator. Non-disjunction would be the result of different chromosomes in the rings that established the relationship with spindles independently.

The presence of laggard chromosomes, unequal distribution of chromosomes at anaphase and presence of anaphasic bridges agree very well with pollen sterility. Haga (1943) also reported the complete pollen sterility in *Lilium* with a ring of $4+10_{II}$.

All these observations lead to the conclusion that this is the case of spontaneous multiple translocations which might have arisen due to change in many genes or due to the presence of some other special genetic constitution (Chaudhari 1968), or changes in the internal and external environments. From the available literature it appears that this may be the first report of spontaneous occurrence of multiple translocations in *Capsicum* sp.

Summary

A plant having spontaneous multiple translocations was isolated in the normal populations of Chilli cultivar CA-960. The plant was very healthy having broad green leaves and big size flowers. The chromosome behaviour was studied from the anther smears. At metaphase I rings of 4 and 8 chromosomes and chains of 4, 6, 8, 10, 12, and 18 chromosomes were observed in most of the microsporocytes studied. Regular formation of bivalents and univalents were also noted. Non-disjunction and irregular distribution of chromosomes, laggards and chromatin bridges were observed at anaphase I.

All these irregularities lead to the formation of unbalanced spores resulting in 90 to 100% sterility. The probable reasons for these anomalies are discussed.

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