Morphological and Cytological Studies on a Radiation Induced Polyploid in *Capsicum annuum* Linn.

C. Indira and Susan Abraham

Department of Botany, University of Kerala,
Kariavattom, Trivandrum, India

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In the course of mutation induction studies on *Capsicum annuum* Linn., an autotetraploid plant was observed in the M_2 population raised from gamma ray irradiated seeds. The present paper deals with morphological and cytological studies on this polyploid.

Material and methods

The variety of *Capsicum annuum* Linn. used in this study is characterized by attractive purple fruits (Fig. 1). Genetically pure seeds were obtained by selfing for three generations. These were subjected to gamma rays at dose levels ranging from 10 to 15 kR. The treated seeds were sown in pots and later transplanted to the field. The resulting M_1 plants were selfed. Each plant was harvested separately and its progeny (M_2) raised in the field. Among the progenies of the 10 kR treated plants, one plant was found to be an autotetraploid. Observations on growth, morphological features, flowering and fruit setting of the polyploid were recorded.

Cytological studies were carried out from flower buds fixed in 1:3 acetic-alcohol and smeared in acetocarmine. Studies on pollen mitosis were carried out from hematoxylin stained preparations. Pollen sterility was determined from acetocarmine-glycerine mounted slides.

Results

Morphological studies

The polyploid was characterized by slower and stunted growth (Fig. 2). The leaves were thicker, broader, large sized (Fig. 3) and deep green in colour as compared to those of the controls. As in other polyploids, the epidermal cells of the palisade and spongy parenchyma as well as the stomata were larger.

Flowering was delayed in the polyploid. The flowers borne on the polyploid were conspicuously larger and a general enlargement of the floral structures was noticeable (Fig. 4). Increase in the number of petals and stamens was also observed in many cases. Abnormal flowers showing dissected floral parts or rudimentary structures were also present (Fig. 5).

The tetraploid was sterile. Though many flowers were produced, only two fruits were formed. The fruits were much smaller than those of the control plants

and fell off before ripening. Seeds were absent in both the fruits.

Cytological studies

Meiosis in the control (diploid) plants of *Capsicum annum* was normal and

Figs. 1-5. 1, plant habit of the diploid *Capsicum annum* Linn. 2, radiation induced tetraploid showing stunted growth. 3, leaf of the diploid (left) and polyloid (right). 4, flowers of the diploid *Capsicum annum* (left) and tetraploid (right). Note the larger size in the tetraploid. 5, abnormal flower of the tetraploid plant (left) and normal flower of the diploid (right).

Figs. 6-13. All figures $\times 850$. 6, diakinesis in the diploid *Capsicum annuum* showing 12 bivalents. 7, diakinesis in the tetraploid showing the doubled number of chromosomes. Note the presence of quadrivalents, trivalents and univalents in addition to bivalents. 8, anaphase I in the tetraploid showing unequal separation. 9, metaphase II in a pollen mother cell showing unequal number of chromosomes. 10, telophase II showing lagging chromosomes. 11, telophase II showing micronuclei. 12, pollen grain of the tetraploid plant showing 19 chromosomes instead of the normal 12 chromosomes in diploid. 13, pollen grain of the tetraploid showing 23 chromosomes.

12 bivalents were observed at diakinesis (Fig. 6). Cytological studies of the polyploid plant showed the doubled number of chromosomes at various stages of meiosis. Various associations of chromosomes like quadrivalents and trivalents were observed along with a high frequency of bivalents at diakinesis (Fig. 7). Univalents were also present, their number varying from 2 to 5 per cell. Anaphase I was irregular and showed unequal disjunction of chromosomes in many cells (Fig. 8). Consequently, variations in chromosome numbers were observed at metaphase II (Fig. 9). Lagging chromosomes seen at anaphase II and later stages (Fig. 10) resulted in the formation of micronuclei at telophase. The number of micronuclei per tetrad varied from one to eight (Fig. 11). Pollen grains of various sizes were noticed in the tetraploid. The percentage of pollen fertility in the tetraploid was rather low, the average for the diploid and the tetraploid being 80.4 and 28.1 per cent respectively. The fertile pollen grains of the polyploid were larger than those of the diploid.

Pollen mitotic studies revealed the presence of grains of varying chromosome numbers. Unlike 12 chromosomes seen in the diploid pollen, in the tetraploid, grains showing increased chromosome numbers like 19 (Fig. 12), 23 (Fig. 13) etc. were encountered.

Discussion

Radiation induced polyploidy is being reported for the first time in *Capsicum annum*. The polyploid plant showed morphological characters like stunted growth and presence of larger, thicker and dark green leaves. Such characters have been reported as occurring in induced polyploids by other workers also (Tapadar 1963, Bose and Panigrahy 1969, Biswas and Bhattacharyya 1971, 1972). The deep green colour of the leaves in polyploids has been attributed to the presence of more numerous and larger chloroplasts (Raghuvanshi and Joshi 1964).

The tetraploid plant flowered about one month later than the diploids. The total number of flowers produced was less, this decrease being primarily due to the non-branching nature of the polyploid. Delayed flowering and lesser number of flowers were observed in polyploid plants by other workers (Tapadar 1963, Biswas and Bhattacharyya 1971). Gigantism in floral parts as well as abnormalities in floral structures were observed in the tetraploid *Capsicum annum*. Raghuvanshi and Joshi (1964) also observed delayed and extended flowering with larger and varied number of floral parts in the colchicoploids of *Capsicum frutescence*.

Total sterility has been observed in the fruits formed in the radiation induced polyploid. Pal *et al.* (1941) obtained fertile polyploids with larger sized fruits in the colchicine induced polyploid of *Capsicum annum* whereas the polyploids produced by Raghuvanshi and Joshi (1964) in *Capsicum frutescence* were sterile. Sterility in the present material may be attributed to abnormalities observed in meiosis.

Summary

The present investigation deals with morphological and cytological studies

of a radiation induced tetraploid *Capsicum annum*. The tetraploid was characterized by stunted growth, presence of thick, large leaves with larger stomata and increase in size and number of floral organs.

Occurrence of varying numbers of quadrivalents, trivalents and univalents was observed in addition to bivalents. Lagging chromosomes seen at anaphase in varying numbers resulted in the formation of micronuclei in the tetrads. About 72% of the pollen produced were aborted.

The polyploid was completely sterile with extremely poor fruit setting. The fruits were devoid of seeds.

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