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Abnormal Spindle Behaviour in Induced Autotetraploid, *Physalis pubescens* L.

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Summary. In the colchicine induced autotetraploid *Physalis pubescens* L., meiotic spindle abnormality was observed in one plant. It is probable that the colchicine treatment may have disturbed the spindle organiser, thereby causing abnormal spindle behaviour. The genetic basis for this abnormality (multipolar spindle) could not be established on account of lack of seed set in the plant showing the abnormal spindle behavior.

Key words: Colchicine – Abnormal spindle – Quadripolar – Multipolar – Spindle organiser

Introduction

Abnormal mitosis and meiosis induced by various agents such as chemical treatments, temperature, irradiation and dehydration has been reported in plants (Giles 1939; Peto 1933; Puza and Srb 1964). Sax (1937) described the effects of changes in temperature in *Tradescantia* and reviewed abnormalities of nuclear and cell divisions. The phenomenon of cell division whether mitotic or meiotic, is a highly complex and delicately balanced one – a composite of several separate but integrated processes. Meiotic spindle abnormalities have been primarily reported in induced autopolyploids, amphidiploids, species hybrids and only rarely in natural diploids. Some of these spindle abnormalities were inherited as a simple (Mendelian) recessive genes. In the C_0 generation of induced autotetraploid *Physalis pubescens* L., tripolar and quadripolar spindles were observed and the findings are reported in this paper.

Materials and Methods

Plants of diploid *Physalis pubescens* L., were raised in pots. The terminal portions of young seedlings of about one week old plants were treated with 0.3% aqueous colchicine. Of the 20 seedlings thus treated five turned out to be tetraploids. One of the tetraploid plants exhibited abnormal spindle behaviour. Standard acetocarmine smears were made in order to study the PMC meiosis in this plant.

Results

Morphology

The plant exhibiting the abnormal spindle behaviour was different from the other tetraploid plants in having wrinkled leaves, stunted growth, often more than five stamens and split corolla lobes. The flower buds were slightly irregular in shape and larger in size. Every stamen in the flower bud was more or less irregular in shape and exhibited the same type of abnormal meiosis. The stigmatic surface was flattened instead of being in the normal capitate condition, which ultimately led to be premature disintegration of the stigma.

Cytology

All the PMCs of the plant with abnormal spindle behaviour were found to be uninucleate. Chromosome pairing at pachytene and diakinesis was normal with various types of chromosomal associations and without any apparent abnormalities other than those expected in the C_0 generation of induced autotetraploids (Fig. 1). At metaphase I in a majority of the PMCs (70%) tripolar spindles were noticed while in a few (30%) quadripolar spindles were observed (Fig. 2). No PMCs with dipolar spindles were seen. As expected, the tripolar and quadripolar spindles led to the formation of three and four nuclei at anaphase I and telophase I (Fig. 3). Irregularities were noticed in the second meiotic division as well. The irregular distribution of chromosomes at anaphase II was reflected by the production of 6–8 nuclei at telophase II and the polysporic condition, where the spores were of different

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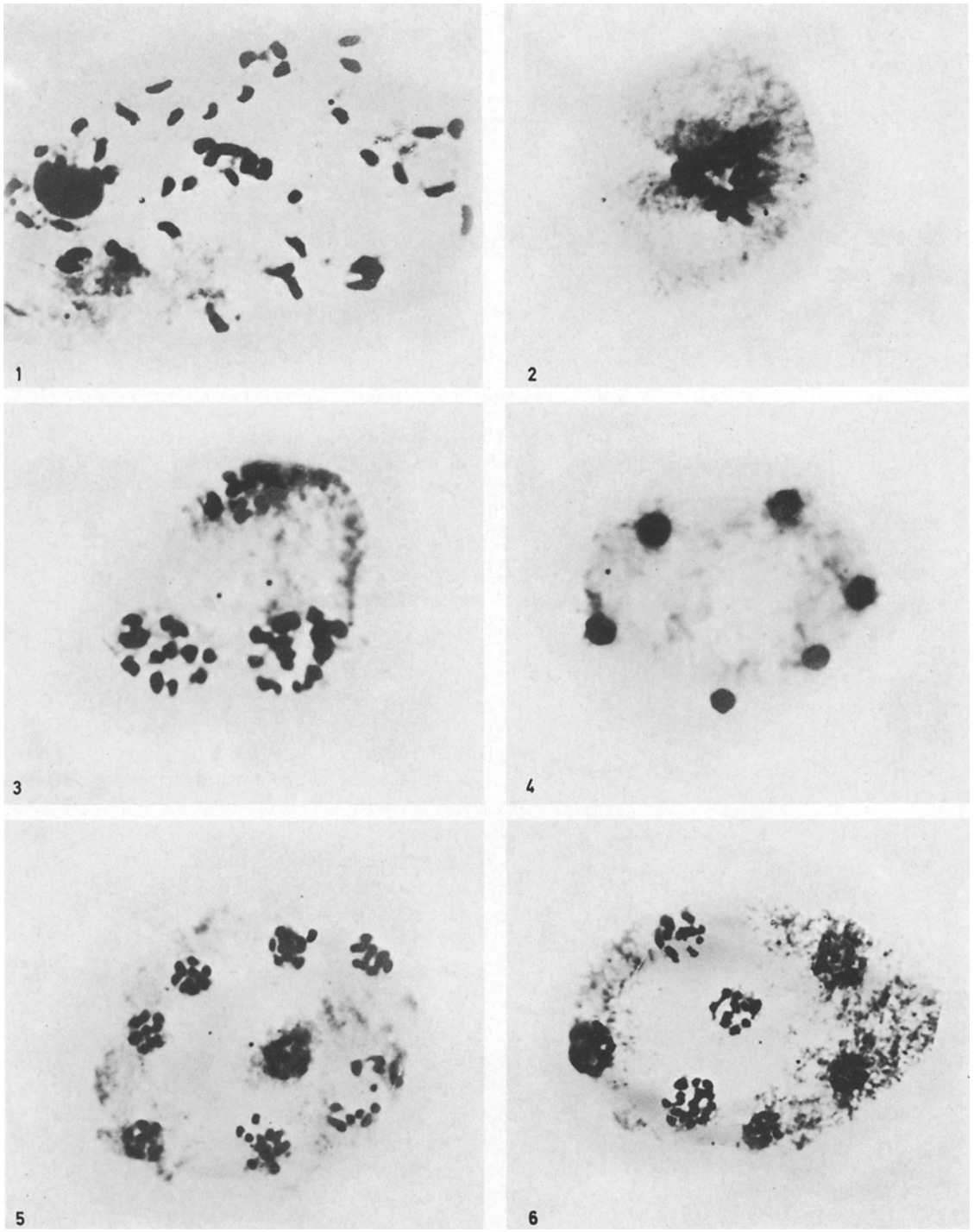

Figs. 1–6. **1** Diakinesis showing 48 chromosomes; **2** Late metaphase showing tripolar condition; **3** Anaphase I showing three groups of chromosomes; **4–6** Second division showing six-eight groups of chromosomes

sizes, (either, 6, 7 or 8 spores) at the pollen quartet stage (Figs. 4–6). Pollen stainability was very low (less than 10%), indicating high pollen abortion.

For a proper understanding of the mode of inheritance of the abnormal spindle behaviour, crosses were made between this plant and the sib tetraploid plants of the same generation which were reasonably pollen fertile. A few fruit were realised when this plant was used as the female parent. The fruit looked apparently normal but had no seeds. No seed was obtained

upon selfing or upon open pollination, indicating that this plant was completely female sterile.

Discussion

The spindle is probably a composite structure in most organisms and a normal spindle appears to be the product of a spindle fiber organiser located on the chromosomes plus pole determinants, synchronized in time and space, although either can produce the spindle unaided in some organisms. The structural abnormalities described here can be interpreted as variations in the behaviour of pole determinants (Swanson and Nelson 1942). The spindle organiser described by Walters (1958) and Tai (1970) is essentially the same as pole determinants described by earlier workers. A unit spindle organiser if broken randomly results in the formation of multipolar spindles (Tai 1970). Multipolar spindles were recorded in *Triticum aestivum* when treated with acetone (Kabarity 1966). When *Allium cepa* was subjected to low temperature treatment multipolar spindles were obtained in their PMCs (Huskins and Chang 1950). In the case of wheat grass the spindle organiser was broken spontaneously due to a gene mutation, resulting in the formation of multipolar spindles (Tai 1970). When 0.2% of aqueous colchicine was injected into young flower buds of wheat which had not entered meiosis it resulted in either achiasmatic meiosis (Dover and Riley 1973) or the induction of multipolar spindles (Dover and Riley 1977). In all these cases colchicine or other experimental agents seem to act directly on the pollen mother cells in producing spindle abnormalities. In the present experiment, on the other hand, colchicine was applied long before the initiation of flowering and therefore could not have acted directly on PMCs. In the present case, colchicine could have altered the stability of the pole determinants in the early seedling stage at the time of treatment and this abnormality could have persisted over many cell generations and been expressed in the PMCs. The wrinkled leaves and other morphological abnormalities listed are possibly the result of similar abnormal spindle behaviour in the somatic tissues.

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Book Reviews

Stanley, S.M.: The new Evolutionary Timetable; Fossils, Genes and the Origin of Species. New York: Basic Books 1981. 222 pp., 56 figs.

Since Darwin in 1859 published his "Origin of Species", the discussions on the evolution theory went through alternating periods of great vehemence and of relative quietness. In the last few years the vehemence is increasing again, focussed on two discussion items: is evolution to be accepted as an historical fact (antithesis evolutionism/creationism), and if so, does evolution elapse gradually or by fits and starts (antithesis gradualism/punctuationalism). Sometimes this discussion even is brought into political spheres (N. Wade, Science, Vol. 211, 2 Jan. 1981, pp. 35–36; L. Beverly Halstead, Nature Vol. 292, 30 July 1981, pp. 403–404). Among the