Pseudo-isochromosomes in pearl millet

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Summary. Meiosis in a plant with 2n = 12+2 pseudo-isochromosomes was studied. The pseudo-isochromosomes were compensating for the loss of the 3rd chromosome pair of the normal diploid complement.

An isochromosome was described by Darlington[2] as a chromosome having 2 identical arms and presumably having arisen by the misdivision of the centromere. Pseudo-isochromosomes[3-5] on the other hand are either the result of reciprocal translocations between opposite arms of a pair of homologous chromosomes or may arise from crossing over in pericentric inversions during meiosis. In pearl millet, there has hitherto been no record of the occurrence of pseudo-isochromosomes.

In plant raised from seeds of a local inbred strain of *Pennisetum americanum* (L.) Leeke (2n = 14), exposed to gamma rays (15 krad), 1 plant out of 30 showed abnormal meiotic behaviour. Acetocarmine squashes of PMCs in this plant revealed the presence of 6 bivalents and 2 univalent chromosomes. These 2 univalents differed markedly in their size. At the pachytene stage both the univalents exhibited fold-back (inter-arm pairing) configuration (figures 1 and 2). These 2 univalents were never observed to pair either between themselves or with any other chromosome of the complement.

At diakinesis, in 86.25% of the cells both the univalents showed a ring configuration (figure 3). In 12.5% of the cells, one formed a ring and the other a rod and in a very few cells (1.25%) both of them remained as rod univalents. At metaphase I, in 5% of the cells, both the univalents were co-orienting on the metaphase plate along with the other bivalents while in 28% of the cells both of them moved to the same pole. In 35% of the cells they were observed to move to the opposite poles (figure 4) and in 32% of the cells only one of them moved to a pole. At anaphase I, in 6% of the cells the larger univalent was observed to divide while in 16% of the cells both the univalents were dividing. At telophase I both were lagging behind in 2% of the cells, whereas in 6% of the cells only one of them was lagging. No micronuclei were observed, indicating that these laggards later moved to the poles.

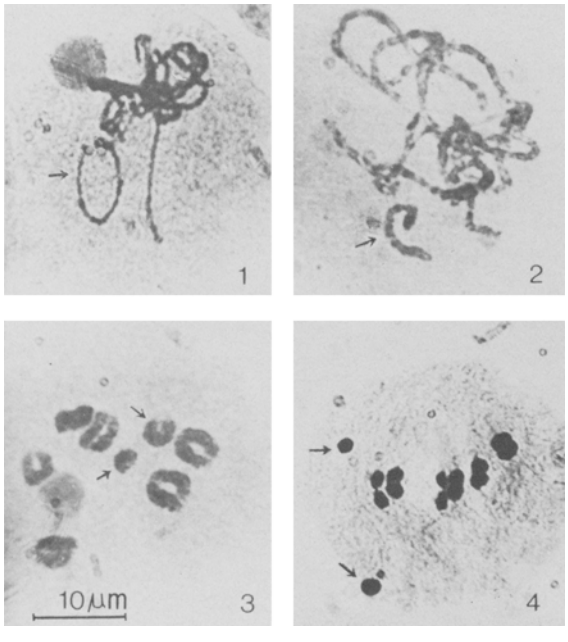

Fig. 1. Pachytene showing fold-back configuration of the long pseudo-isochromosome (→). Fig. 2. Pachytene showing fold-back configuration of the short pseudo-isochromosome (→). Fig. 3. 2-ring pseudo-isochromosomes (→) at Diakinesis. Fig. 4. Metaphase I showing 2 pseudo-isochromosomes moving to opposite poles (→).

The fold-back configuration of the 2 univalent chromosomes at pachytene, the ring univalent formation, and the absence of pairing either among themselves or with any other chromosome suggest that these univalents might be either iso or pseudo-isochromosomes. The possible way of distinguishing cytologically between these 2 types depends, in the absence of any chromosome marker, on the extent of inter-arm pairing which in turn depends on the size of the homologous segments. In pseudo-isochromosomes the 2 ends are homologous and pair at meiosis as isochromosomes do, but the segments proximal to the centromere are not homologous. The mode of origin of the present material i.e., from irradiated seed, and its chromosome constitution suggests that it is more probable that these 2 univalents represent 2 pseudo-isochromosomes rather than true isos.

From the analyses of chromosome length and arm ratios at the pachytene stage, the 3rd chromosome pair of the normal diploid complement was found to be missing. Since the plant with pseudo-isos did not differ from its normal sibs in its exophenotype, it can be assumed that the 2 pseudo-isochromosomes were compensating for the loss of the 3rd chromosome pair and were probably derived from it. Following the terminology of Khush[6] the plant can be named as 'double pseudo-isosomic' with the chromosomal formula, 2n = 6″ + 1′ + 1′.

The pollen fertility in this plant ranged from 40 to 50%. The plant was selfed and crossed reciprocally to a standard diploid stock. Progeny raised from the selfed as well as crossed seed produced plants showing 7 bivalents at PMC meiosis. In no case was either the parental condition or any duplication or deficiency observed. The most likely explanation for our failure to recover the mutant type among the progeny is that the plant with the pseudo-isochromosomes was in fact a chimera, a situation not uncommon after irradiation. The earheads (first two) used for cytological study belonged to the mutated sector while those used for selfing as well as crosses were from the sector which was not mutated or at least did not carry the same mutation. The reduction in pollen and seed fertility may have any of a number of causes, like gene mutations etc., which are quite common after irradiation.

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