Induced Interchange Heterozygosity in Pearl Millet, *Pennisetum typhoides* (Burm.) STAPF et HUBB

Chromosome interchanges provide an important evolutionary mechanism in the sense that they may lead to changes in chromosome morphology and number, thus resulting in repatterning of karyotypes[1] and alteration of basic chromosome numbers[2]. They also constitute good tools for basic studies in cytology and genetics[3-5], for the creation of new variation and may thus prove useful in plant breeding[6]. The role of translocations in the evolution of the karyotype of pearl millet, *Pennisetum typhoides* (Burm.) Stapf et Hubb., is poorly understood. The present study was conducted to obtain preliminary information on the induction of multiple chromosome interchanges in pearl millet.

Material and method. Seeds of the var. T55 of pearl millet were exposed to 20 kR and 30 kR ^{60}Co γ-rays; 200 seeds were used for each treatment. The treated and control seeds were sown in pots. Meiosis in many of the M_1 plants was studied and those having translocations were identified. Seeds from these plants were given another cycle of γ-irradiation (20 kR). Similarly, 3rd, 4th and subsequent cycles were repeated.

Observations and discussion. Control plants growing exactly under the same conditions as the treated ones, showed normal meiosis with 7 bivalents (Figure 1). While in some of the M_1 plants interchanges of 4 chromosomes were observed (Figures 2 and 3), complex configurations involving 6 to 8 chromosomes (Figure 4) were obtained in the M_2 and M_3 populations. The translocated chromosomes formed either chains (Figure 2) or rings (Figure 3). The chains were either rod-, J- or U- shaped. The multiple interchanges involving the 7th chromosome, i.e. the satellited chromosome, were generally of the chain-type.

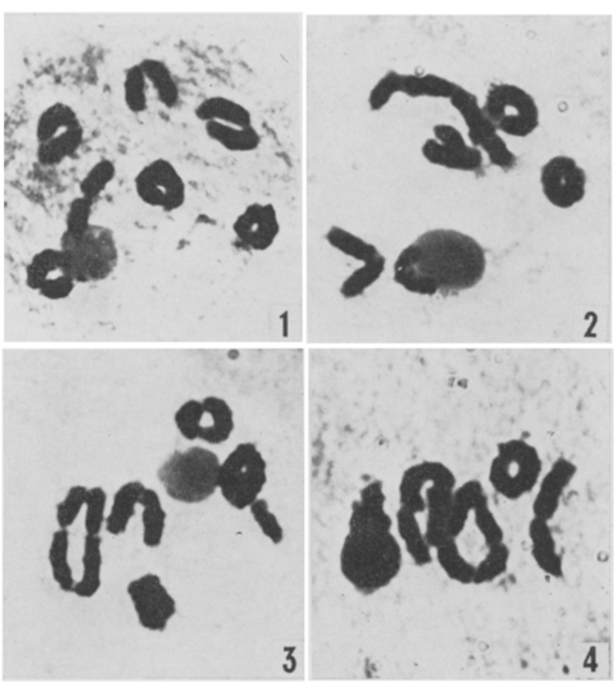

Fig. 1. A PMC from a normal plant showing 7_{II}.

Fig. 2–4. PMC's from treated plants showing different chromosome interchanges.

Fig. 2. A chain of 4 chromosomes, and 5_{II}.

Fig. 3. A ring of 4 chromosomes, 4_{II} and 2_I (1 univalent is overlapping).

Fig. 4. A complex interchange involving 8 chromosomes, and 3 bivalents.

In M_3 population 2 plants, each with a multiple interchange of 8 chromosomes (Figure 4), were isolated. In M_4 a plant with complex interchange involving 10 of the 14 chromosomes was observed. In this plant PMC's having two interchange multiples of 6 and 4 chromosomes were also met with. Free univalents and chromosome fragments, presumably centric ones, were also observed. Pollen- and seed-sterility increased roughly in proportion to the number of chromosomes involved in interchanges. In the two M_3 plants having multiple interchanges of 8 chromosomes, pollen fertility, as judged by their stainability with 2% acetocarmine, was 35%. Obviously, translocation heterozygosity resulting in unequal distribution of chromosomes at anaphase leads to the formation of imbalanced gametes, and thus in pollen sterility. At anaphase I, 8:6, 9:5 and rarely 10:4 distributions of chromosomes were observed, in addition to the normal 7:7 segregation.

Interchanges involving more than 10 chromosomes were not recovered even after the 5th and 6th cycles of irradiation, showing thereby that possibly the upper limit, at least in this particular experiment, had been reached. Higher interchange multiples could not be obtained, perhaps because of the limitations imposed on viability. The gametic sieve seems to operate more drastically when more chromosomes are involved in interchanges. The different translocation stocks are now being intercrossed possibly to get an interchange stock involving all the 14 chromosomes. These translocation stocks which give 8:6 and 9:5 anaphase separations, are also being used to get aneuploids, including trisomics and possibly monosomics, in pearl millet.

Chromosome interchanges are also known to occur spontaneously in certain lines of pearl millet[7] and they have also been induced artificially[8]. Whether any adaptive advantage is associated with the naturally occurring interchanges is yet to be discovered. It may, however, be possible to get certain translocation stocks with favourable gene combinations which may also help in fixing heterosis in this cross fertilizer.

Zusammenfassung. Es wird ein durch Gammastrahlen induzierter multipler Chromosomenaustausch durch Translokation bei *Pennisetum typhoides* beschrieben. Mehrfache Bestrahlung erzeugt komplexe Heterozygoten, in welchen bis 10 der 14 Chromosomen am «interchange» beteiligt sind. Höhere Zahlen wurden nicht erhalten, da das gametische Sieb möglicherweise drastischer wirkt, wenn mehr Chromosomen eine Translokation erfahren haben. Die Translokationsstämme werden benutzt, um Aneuploidie bei Hirse zu erzeugen.

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