COMPLETE INTERCHANGE STOCK IN PEARL MILLET

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Complex chromosomal interchange stocks involving up to the complete haploid set (when crossed with standard normal produced a ring of all the 14 chromosomes at metaphase I), have been synthesised in pearl millet. Joint use of recurrent irradiation and intercrossing of specific translocations was most effective in synthesizing the complexes. The stocks are being used for gamete selection, inbred production and for locating genes controlling apomixis.

INTRODUCTION

Burnham (1946) suggested that "Oenthera type" complex interchange stocks may be used for gamete selection and inbred production in maize and other crops. In cross-fertilized crops, like maize and pearl millet, where heterosis breeding is most remunerative, efficient production of *elite* inbreds is of great importance. The present paper communicates on development of multiple interchange stocks and their possible uses in developing inbreds and production of hybrid seed in pearl millet.

MATERIALS AND METHODS

Five single stocks viz., T 1–7, T 1–3, T 2–4, T 5–4 and T 5–6 (Singh and Tyagi 1973) were intercrossed and irradiated for joining the different interchanges. By intercrossing, the parental interchanges were combined in one background. Meiotic associations in the F_1 hybrids of crosses between selected stocks revealed the interchange pattern of the parents. Plants in the selfed progenies of F_1 hybrids were classified into two groups (*i*) highly sterile plants (interchange heterozygotes), and (*ii*) fertile plants (new interchange homozygotes and normal homozygotes). All the plants of second group were selfed and crossed with standard normal. The plants showing normal pollen fertility when selfed and high pollen sterility and desired meiotic configuration when crossed were identified as interchange homozygotes.

In the irradiation programme, dry seeds of selected interchange stocks were treated with 20 Kr of gamma ray (^{60}Co) and were space planted in field. Using pollen sterility as a marker of new interchanges, partially sterile heads in M_1 generation were selected and those exhibiting a ring or chain quadrivalent at metaphase I were selfed. In the progeny of such selfed plants, based on pollen sterility and the test cross configurations, new and parental interchange homozygotes were identified.

For cytological examination, young spikelets were fixed in modified Carnoy's reagent (6 parts absolute ethyl alcohol, 3 parts chloroform and 1 part glacial acetic acid) and anthers were squashed in acetocarmine. Diakinesis and metaphase I configurations were recorded as multivalents and/or bivalents. The configuration

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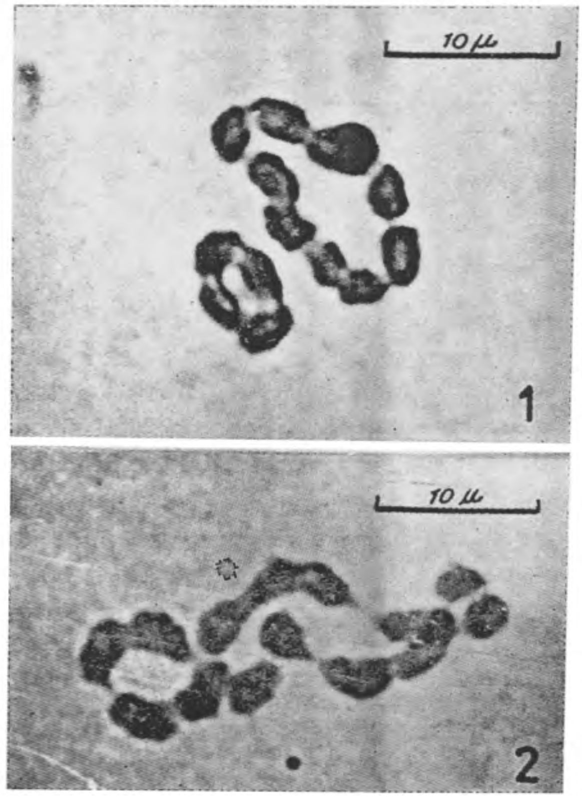

FIGS. 1–2. Metaphase I. 1, rings of ten (0_{10}) and four (0_4) chromosomes; 2, ring of all the 14 (0_{14}) chromosomes.

involving the maximum number of chromosomes in a multivalent (s) was accepted as the diakinesis and metaphase I configuration for that material.

RESULTS

In the crosses T 1–7 × T1–3 and T 5–6 × T5–4 (all the single interchange heterozygotes showed a quadrivalent at metaphase I) a hexavalent was formed in the F_1's and desirable test cross hybrids (in the former cross hexavalent was associated with nucleolus at diakinesis, chromosome 7 is nucleolus organising chromosome in pearl millet) and the newly obtained interchange stocks were designated as T 7–1–3 and T 6–5–4, respectively. Designation correctly identifies the chromosomes involved but not necessarily the correct order. The stock T 7–1–3 when crossed with T 2–4 and T 5–6, in F_1's and desirable test cross hybrids, formed a hexavalent and a quadrivalent and the new interchange stocks were designated as T(7–1–3) (2–4) and T (7–1–3) (5–6), respectively. The F_1 hybrids of the cross between T(7–1–3) (2–4) and T 7–1–3–5–6 exhibited two quadrivalents, while in the desirable test cross hybrids a decavalent and a quadrivalent were seen (Fig. 1). Decavalent was found to be associated with nucleolus at diakinesis. The newly obtained interchange stock involving all the seven pairs of chromosomes in two different multivalents was designated as T(7–1–3–5–6) (2–4).

In irradiation programme, out of 43 partially sterile plants selected in M_1 generation of T(7–1–3) (5–6), six showed a quadrivalent at metaphase I. In M_3 generation test cross hybrids, line showing a decavalent was selected and it was designated as T 7–1–3–5–6. In some lines an octavalent and a quadrivalent were observed, while the remaining exhibited two quadrivalents. In M_1 generation of T (7–1–3–5–6) (2–4) seven of the 51 partially sterile plants showed a quadrivalent at metaphase I. In M_3 generation test cross hybrids, line showing a multivalent involving all the 14 chromosomes at metaphase I (Fig. 2), was selected. The newly obtained complete interchange stock was designated as T 7–1–3–5–6–2–4. In some of the M_3 test cross lines, an octavalent and a quadrivalent were seen, while in others, a decavalent was found.

Pollen fertility in all the multiple interchange heterozygotes decreased as the number of chromosomes involved increased. The interchange heterozygote with all the 14 chromosomes in a ring at metaphase I showed 99.9 per cent pollen sterility.

Discussion

Intercross and irradiation approaches, independently, have been reported to be successful in production of multiple interchange stocks in barley (Nishimura 1961; Nishimura and Kurakami 1953; Sisodia and Shebeski 1965), maize (Burnham 1966) and *Companula* (Darlington and LaCour 1950). In the present study the combined use of intercrossing and irradiation was found to be more effective in producing multiple interchange stocks as compared to the independent use of irradiation and intercrossing of the selected stocks. Irradiation induced interchanges are expected to be random, thus, synthesis of larger rings of desired chromosome combinations was not directed, as expected. Also, irradiation of such complexes, resulted in breakdown of the parental multiple associations. As regards the synthesis of larger complexes through intercrossing of the selected stocks, success depends on the possibility of crossingover in the differential segment (the region between the break points of two interchanges involving a common chromosome). By this method it was not possible to combine more than three pairs of chromosomes. In the present study, low crossingover was observed in differential segments and thus the crossing method had restricted use in synthesising larger complexes. However, such interchanges were transferred as independent complexes in one background by intercrossing, which were further combined together by irradiation induced additional interchange between the parental translocations. Therefore, intercrossing of selected stocks coupled with irradiation was found to be much more efficient in synthesising multiple complexes involving upto all the 14 chromosomes in pearl millet.

The extremely high sterility of the heterozygous interchange stock involving all the 14 chromosomes in a ring is a barrier to the testing of the "Oenothera" method of gamete selection. However, varying degrees of fertility in the different interchange complexes involving same number of chromosomes were found. Such stocks are being used for gamete selection, inbred production and for searching genes controlling apmixis in pearl millet.

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