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A Co-incidence of Interchange Trisomy with Interchange Heterozygosity in Pearl Millet—*Pennisetum americanum* (L) Leeke

Z VISHNUVARDHAN and N LAKSHMI

Cytogenetics Laboratory, Department of Botany, Nagarjuna University, Nagarjunanagar 522510, AP

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A co-incidence of interchange trisomy with interchange heterozygosity was recorded in pearl millet for the first time. Meiotic studies revealed the presence of an extra chromosome (2n+1) and the model association of 1 V+*1* IV+3 II. Pollen fertility was very low and the plant was completely sterile. It is inferred that the translocated chromosomes involved in the second translocation are non-nucleolar and could have been contributed by the male parent.

Key Words: Pearl millet, Interchange trisomy, Interchange heterozygosity, Quinquivalent

Introduction

In an interchange trisomic the extra chromosome occurs in an interchange heterozygote. The extra chromosome may be normal type 1, normal type 2, interchange type 1^2 and interchange type 2^1 (Sybenga 1972). The phenotypic effect of these trisomics is comparable to that of primary trisomics and depends on the genetic make up of the extra chromosome. In pearl millet reports on the occurrence of interchange trisomics are scanty. Manga (1977) observed two interchange trisomics in the progeny of an interchange heterozygote while Narasingarao and Narayanarao (1977) recorded them in the fourth generation progeny of a primary trisomic. In the present study a co-incidence of interchange trisomy with interchange heterozygosity was observed due to the incidence of a second translocation involving different chromosomes. The present communication concerns the meiotic behaviour, morphology and genetic consequences of this mutant hitherto unrecorded in pearl millet.

Material and Methods

In February 1978 seed material of the variety J-88 was subjected to γ-irradiation. In the 35 kR progeny, a translocation heterozygote was isolated. This was

crossed with another translocated plant and an interchange heterozygote exhibiting an association of 6 chromosomes was synthesized in October 1978. In open-pollinated progeny of this translocation heterozygote a ditertiary compensating trisomic (5.8 and 9.6) was obtained in October 1979. From the open-pollinated progeny of this an interchange trisomic was screened. This formed the parental stock of the present mutant which shows interchange trisomy as well as interchange heterozygosity. Young ear heads were fixed in 1 : 3 acetic alcohol. Conventional acetocarmine technique was followed for meiotic studies. Photomicrographs were taken from sealed preparations. Morphological parameters of the mutant and disomic plants were noted. Quantitative data on height, number of tillers per plant, length and width of leaf, length of ear etc., were recorded at the harvest time.

Table 2 *Frequency in % of various chromosome associations in trisomic plant at diakinesis*

Chromosome associations	Number of cells observed	% of cells
1 VC+1 IVR+3 II	72	33.48
1 VST+1 IVR+3 II	9	4.19
1 VYT+1 IVR+3 II	4	1.86
1 VPT+1 IVR+3 II	13	6.05
1 VPT+5 II	3	1.40
1 VC+1 IVC+3 II	4	1.86
1 VC+5 II	2	0.93
2 IVR+3 II+1 I	59	27.44
1 IVR+1 IVC+3 II+1 I	9	4.19
1 IVR+1 IIIC+4 II	17	7.91
1 IVR+1 IIIYT+4 II	7	3.25
1 IVC+1 IIIYT+4 II	5	2.32
1 IVR+5 II+1 I	8	3.72
1 IIIC+6 II	3	1.40

C, Chain; *R*, Ring; *ST*, Spoontype; *YT*, Y-type; and *PT*, Pan type

Observations

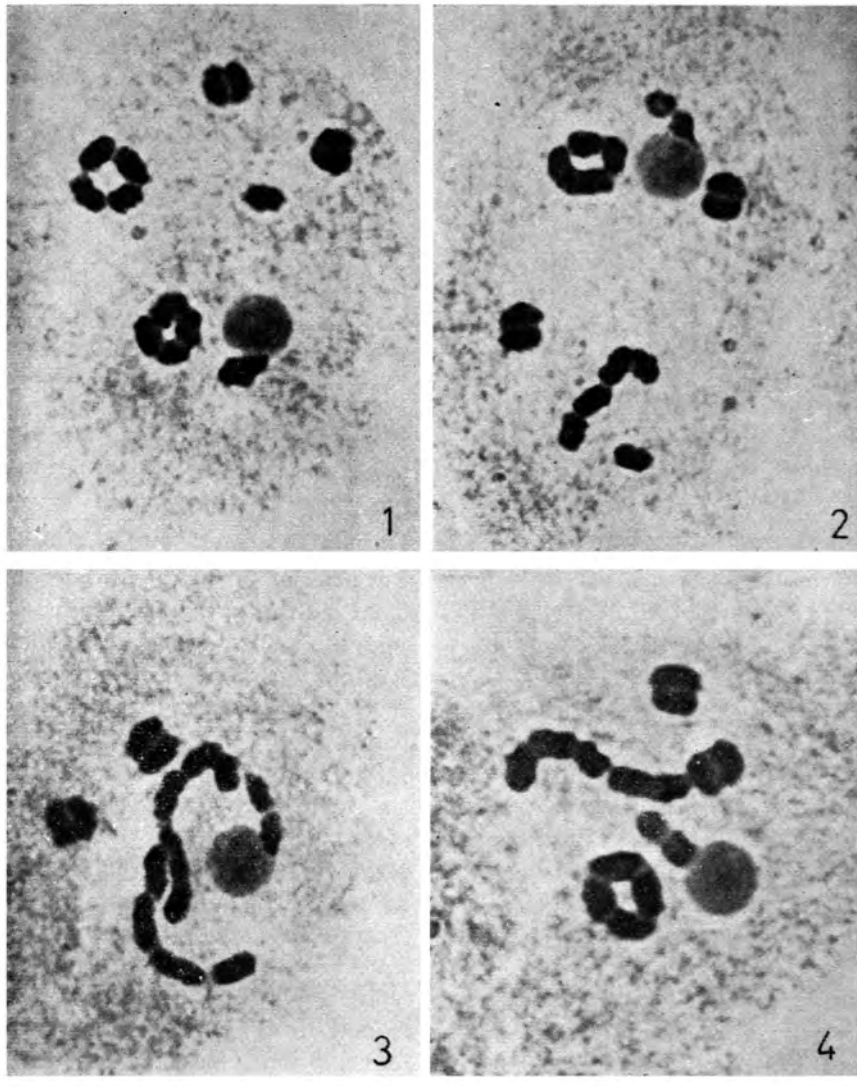
The mutant plant was remarkable in being taller than diploid with as many as 10 tillers, narrow, stiff, short erect leaves and lax ears (table 1). Das and Srivastava (1969) observed both increase and decrease in the number of tillers per plant in the interchange trisomics of Barley. However, in pearl millet a remarkable increase in the number of tillers was noticed from 2 in the disomic to 10 in the mutant and also in another interchange double trisomic [disomic 3; trisomic 8 (Lakshmi & Vishnuvardhan unpublished data)].

Table 1 *Comparative morphometrics of trisomic and disomic plants*

Character	Trisomic	Disomic*
Height (cm)	110	101.36
Tillers	10	2
Leaf size (cm)		
Length	38	45.35
Width	2	2.32
Ear head length (cm)	16	17.7

*Average of ten plants

PMC meiosis revealed the presence of an extra chromosome (2n+1) in all the cells (figures 1–4). At diakinesis and metaphase I, the important configuration observed in highest frequency (47.44%) was 1 V+1 IV+3 II (figures 3 & 4). Other configurations observed next in frequency were 2 ring quadrivalents+3 II+I (31.63%) and 1 IV+1 III+4 II (13.48%). The data relating to the frequency of different types of associations are set out in table 2. A pentavalent in an interchange trisomic may assume various configurations depending upon the number and position of chiasmata. Here at diakinesis and metaphase I four types of quinquivalents were observed



Figures 1 – 4, *1*, Diakinesis showing 2 IV + 3 II + 1 (×1600); *2*, Diakinesis showing ring of four + chain of four + 3 bivalents + one univalent (×1625); *3*, Diakinesis showing chain of five + chain of four + 3 bivalents (×1625); *4*, Diakinesis showing chain of five + ring of four + 3 bivalents (×1630)

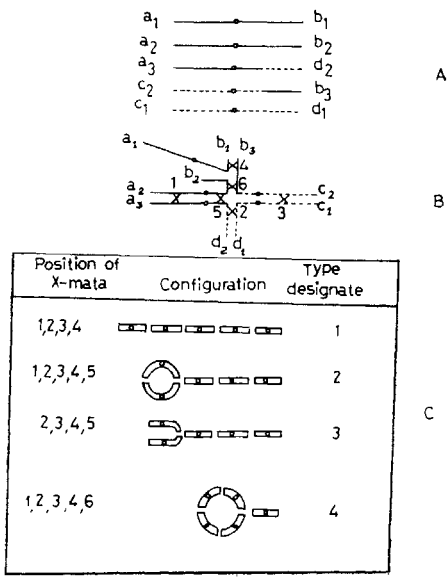


Figure 5A – C, *A,* The five chromosomes of the complement; *B,* The pairing configuration showing the positions of chiasmata (1,2,3,4,5,6); *C,* Configurations that are formed at metaphase I. Type designate: 1, chain type; 2, spoon type; 3, Y type; 4, pan type with four chromosomes in the pan

(figure 5). According to their shape they were classified into four types viz., straight chain type, Y-type, spoon type and pan-type (figure 5) of these the straight chain type was most frequent (36.27%) followed by pan type (7.45%). The configuration of type 1 requires the least number of chiasmata and no more than one per pairing arm. Type 2 requires a minimum of two chiasmata in one set of three homologous arms but only one in othe ther. Type 3 requires a minimum of 4 chiasmata and type 4 five chiasmata. At metaphase I the two quadrivalents present were mostly of ring type and exhibited adjacent orientation. Average chiasma per cell was 13.00 when compared to the disomic 12.26 and terminalization coefficient was 0.95. Anaphase I distributions were mainly 8–7 (65%) and 7–1–7 (15%) types. However, in 2.5% of cells chromatin bridges and in 7.5%, 9–6 seggregations were also found. Pollen fertility was very low (35%) and there was no seed set either on selfing or on crossing and open pollination.

Table 3 *Anaphase I distribution*

Distribution	Number of cells	Percentage
8 : 7	52	65.0
7 : 7 + 1 L	6	7.5
7 : 7 + dividing laggard	6	7.5
7 : 6 + late disjoining II	8	10.0
7 : 7 + chromatin bridge	2	7.5
9 : 6	6	7.5

Discussion

Presence of an extra chromosome is a clear indication that the plant is a trisomic. An association of five chromosomes is a characteristic feature of both tertiary and interchange trisomics but the former could not form a ring quadrivalent and univalent. In the present case as can be seen from the table 2, ring quadrivalents and univalents were quite prevalent. Hence this plant is an interchange trisomic. Another interesting feature observed is the coincidence of interchange trisomy with interchange heterozygosity. This is revealed by the formation of another ring or chain of four chromosomes. Neither the interchange trisomic association of five chromosomes nor the second interchange complex of four chromosomes are in association with the nucleolus thereby suggesting that they are non-nucleolar in nature. The increase in the frequency of chiasmata in the trisomic may be due to the formation of higher associations (pentavalents and quadrivalents). High

pollen sterility and absence of seed set can be attributed to the formation of aneuploid unbalanced gametes with many duplications and deficiencies as a consequence of two interchanges and one extra chromosome. As the translocated stocks are available in the field, the male gamete could have contributed the translocated chromosomes involved in the second interchange.

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