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Trisomic categories in pearl millet (*Pennisetum americanum* (L.) Leeke)

P. N. Rao, A. Nirmala and P. Ranganadham
Department of Botany, Andhra University, Waltair-530 003, India

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Summary. In pearl millet [*Pennisetum americanum* (L.) Leeke], in the open pollinated and crossed progenies of autotriploids, desynaptics and translocation heterozygotes, two primary trisomics, one each of secondary and tertiary trisomics, two primary trisomics with interchanges, two interchange secondary trisomics, and three interchange tertiary trisomics were located. These categories were determined on the basis of chromosomal associations formed at meiosis. In one other trisomic, its category, whether tertiary or interchange trisomy, could not be determined. Some of these categories, like the secondary trisomy and interchange tertiary trisomy, are reported for the first time.

Key words: Pearl millet – Primary – Secondary – Tertiary trisomy – Interchanges

Introduction

The occurrence and pairing properties of different types of trisomics in pearl millet (*Pennisetum americanum* (L.) Leeke, 2n = 14) have been reviewed by Pantulu and Rao (1982) and Jauhar (1981). Further cases of primary and tertiary and interchange trisomics were reported by Koduru et al. (1981), Sai Kumar et al. (1982, 1985) and Singh et al. (1982). Ditertiary compensating trisomics were isolated by Saini and Minocha (1981) and Lakshmi and Vishnuvardhan (1984). In this investigation several categories of trisomics were obtained; based on their meiotic pairing behavior the type of trisomy was identified and the results are presented here.

Materials and methods

The different kinds of trisomics were located in open pollinated and crossed progenies of autotriploids, desynaptics, and translocation heterozygotes, in a line (L.S. 356) of pearl millet obtained from Millet Research Station, Lam, Andhra Pradesh. Cytological studies were made from PMCs using acetocarmine squash technique. To explain the chromosome configurations, the two arms of a chromosome were arbitrarily labelled *A B*, *C D* etc., those of its homologue as *a b*, *c d* etc., in isochromosome as *A A*, *B B* etc., and in translocated chromosome as *A C*, *D E* etc.

Results and discussion

Primary trisomics

Two primary trisomics (33-20-7, 17-7-8) were isolated from the open pollinated progenies of autotriploids. Gill et al. (1970) and Manga (1976) identified the different primary trisomics on the basis of plant phenotype. though their classifications do not agree completely. One of the trisomics (17-7-8) corresponded to "lax type" and the other (33-20-7) to "broad type" trisomic of Gill et al. (1970). Both were nonnucleolar (Fig. 1 a). The trivalent frequencies per PMC in the two varied from 0.56 in 17-7-8 to 0.54 in 33-20-7 (Table 1).

Primary trisomics with interchanges

Two different primary trisomics, one of them nucleolar (9-6-4) and the other nonnucleolar (17-7-12), with interchange complexes involving three nonhomologous pairs were located in the progenies of crosses between autotriploids (female) and multiple interchange heterozygotes (with associations of six chromosomes). While the trisomic condition showed trivalent formation, the interchange configurations involved chains of four and

Table 1. Meiotic pairing in the different categories of trisomics (2n + 1) in pearl millet

Ser. no.	Plant no.	Trisomic category	Higher associations	III				II		I	No. of PMCs
				C	Y	F	R	R	Ro		
1	33-20-7	Pri. tri.	–	35	1	10	–	401	148	39	85
2	17-7-8	Pri. tri.	–	96	6	21	–	1,019	370	108	217
3	9-6-4[a]	Pri. tri. with int.	VI (C-24, R-61), IV (C-9)	1	19	6	–	221	175	84	100
4	17-7-12	Pri. tri. with int.	VI (C-47, R-31), V (C-10), IV (C-7)	25	6	65	–	264	135	18	110
5	17-6-8[a]	Sec. tri.	–	52	32	–	8	524	224	28	120
6	5-1-12	Int. sec. tri.	V (C-16, R-3), IV (C-3, R-2)	16	2	1	–	185	68	12	46
7	1-11-10[a]	Int. sec. tri.	VII (C-24, R-4), VI (C-12, R-2), V (C-12)	28	12	8	–	402	212	28	116
8	14-45-20	Ter. tri.	V (C-19)	31	1	3	–	292	139	18	72
9	18-7-2	Ter. or int. tri.	V (C-12, PL-6, FC-2)	26	–	7	–	222	125	7	60
10	15-8-6[a]	Int. ter. tri.	VII (C-8, PL-2), V (C-46, PL-5, PS-4, FC-3), IV (C-8, R-4)	54	14	9	–	675	240	21	166
11	17-8-1	Int. ter. tri.	VII (C-9, PL-1), VI (C-2), V (C-30, PS-2), IV (R-4)	54	2	2	–	532	219	31	131
12	14-46-1	Int. ter. tri.	IX (C-1, FC-1), VIII (C-1), VII (C-8), VI (C-1, R-1), V (C-36, PL-1), IV (C-12)	57	–	4	–	450	360	105	149

[a] With O-5 B chromosomes
Int = interchange, Pri = primary, Sec = Secondary, Ter = tertiary, Tri = trisomic,
C = chain, F = frying pan, FC = forked chain (>---), PL = pan with long handle (⊂---), PS = pan with short handle (◇—), R = ring, Ro = rod, Y = Y shaped

five, and rings of six chromosomes (Table 1, Fig. 1 b–d). Trivalent frequency per PMC varied between the two from 0.26 in 9-6-4 to 0.87 in 17-7-12, and the frequency of higher associations remained more or less the same. Such primary trisomics with interchanges were recovered by Tyagi (1976) in the progenies of crosses of four different primary trisomics with translocation tester stocks and by Koduru et al. (1981) in the progenies of a triploid interchange heterozygote.

Secondary trisomic

Secondary trisomy has not been reported so far in pearl millet (Jauhar 1981). The secondary trisomic (17-6-8) in this study was isolated in the open pollinated progeny of a desynaptic plant. In 6.7% of the PMCs a ring of three chromosomes (Table 1, Fig. 1 e) was found, indicating that the extra chromosome is an isochromosome which appears to belong to a long arm as adjudged from its larger size.

Interchange secondary trisomics

Two plants (5-1-12 and 1-11-10) of this type were found in the progenies of crosses between translocation heterozygotes, one forming associations of four and the other of six chromosomes with normal diploids (male). In plant 5-1-12, a ring of five chromosomes (Fig. 1 f) in 6.5% of the PMCs, and in the other plant 1-11-10, a ring of seven chromosomes (Fig. 1 g) in 3.5% of the PMCs were found (Table 1). The ring configurations observed are possible only when an isochromosome is present (*A b, b c, c c, C D, d a* in the case of ring of 5; *e d, D B, b a, A A, A C, c f, F E* in the case of ring of 7). In the former plant, a few PMCs were deficient for one to three pairs of chromosomes in the complement (Fig. 1 f). The isochromosome in plant 1-11-10 is quite small and therefore is believed to be a short arm iso. Ring trivalents were not observed. Thus, in the three plants with isochromosomes in this study, different isos seemed to have been involved. The isochromosomes probably originated from univalent chromosomes through misdivision of the centromere. Pantulu (1967) obtained chains of seven chromosomes involving the nucleolar pair, and rings of three chromosomes in an irradiated material of pearl millet, and implied the presence of an isochromosome to account for these configurations.

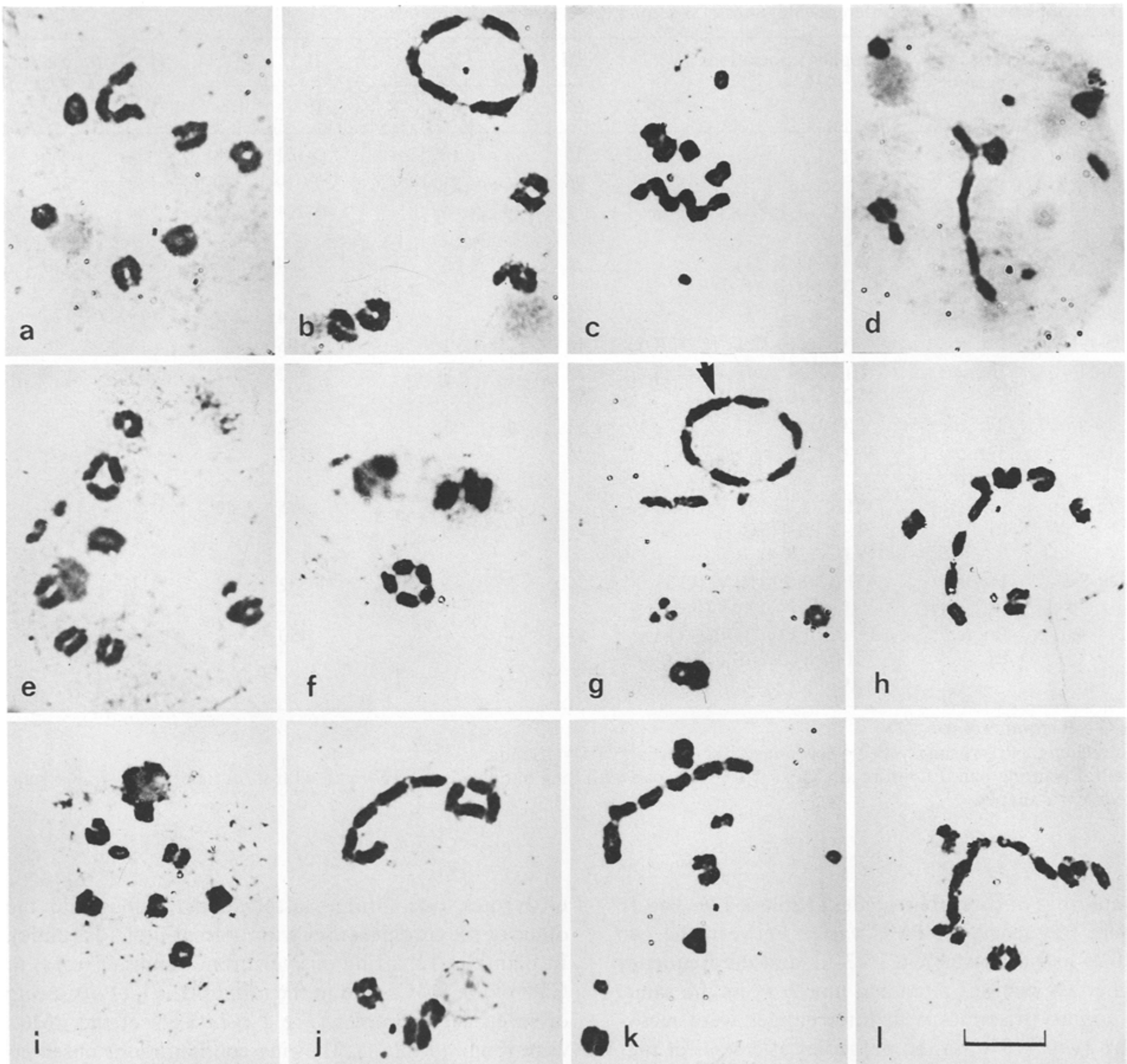

Fig. 1 a–l. Diakinesis and metaphase I in the different trisomic (2n + 1) categories of pearl millet. **a** 1 III (chain) + 6 II. **b** 1 VI (ring) + 1 III (frying pan involving nucleolar chromosomes) + 3 II. **c** 1 VI (zig-zag chain) + 4 II + 1 I + 1 B. **d** 1 V (chain) + 1 III (frying pan) + 3 II + 1 I + 2 Bs. **e** 1 III (ring) + 6 II + 4 Bs. **f** 1 V (ring) + 4 II (one nonnucleolar bivalent missing). **g** 1 VII (ring, arrow indicates the small isochromosome) + 4 II + 4 Bs. **h** 1 V (chain) + 5 II. **i** 7 II (all rings with terminalized chiasmata) + 1 I. **j** 1 V (chain) + 5 II. **k** 1 VII (frying pan) + 4 II + 4 Bs. **l** 1 IX (forked chain) + 3 II (interlocking of chain of IX and a ring bivalent). Bar indicates 10 μ

Tertiary trisomics

One plant (14-45-20) found in the progenies of crosses between a translocation heterozygote (with a ring of four) and a normal diploid (male) and another plant (18-7-2) isolated in the progenies of crosses between two translocation heterozygotes (each with a ring of four) showed associations of five chromosomes in 26.3% and 33.3% of the PMCs, respectively (Table 1, Fig. 1 h, j). Tertiary trisomics, in which the extra chromosome is a translocated chromosome (*A C*) having homologies with two different pairs of chromosomes (*C D*, *c d* and *A B*, *a b*), are characterised by the formation of a dumbbell-shaped association of five, nonformation of a ring of four, and formation by the concerned chromosomes ring bivalents with completely terminalised chiasmata.

In interchange trisomics, the extra chromosome is normally (*C D*), having homology to two other pairs involved in an interchange (*e f*, *F c*, *C D*, *d E*). They are distinguished by the formation of a characteristic association of five, with a ring bivalent (*C D*, *c d*), both sides of which are connected by a chain trivalent (*d E, e f, F c*), formation of a ring of four, and nonformation of ring bivalents with terminalized chiasmata by the concerned chromosomes.

In both plants in this study, neither the special types of associations of five, nor rings of four were observed. However, in plant 14-45-20 in a few cells when the extra chromosome remained unpaired, the rest of the chromosomes formed ring bivalents with terminalized chiasmata (Fig. 1 i). Therefore, it is believed that this plant is a tertiary trisomic. For the other plant (18-7-2), with the present data it is not possible to determine whether it is a tertiary or an interchange trisomic.

Interchange tertiary trisomics

Two plants (15-8-6 and 17-8-1) forming associations of seven chromosomes in 6.0% and 7.6% of the PMCs, respectively, were found in the progenies of crosses between two interchange heterozygotes involving four chromosomes.

The associations of seven were either a chain or a frying pan (Table 1, Fig. 1 k). The extra chromosome here is a translocated chromosome (*E A*) connecting the interchange complex of four (*a c, C D, d b, B A*) with an unaltered pair (*E F, e f*). Configurations comprising five, four and three chromosomes were also present in 42.2% and 29.0% of the PMCs, respectively. This evidence and their disomic siblings forming associations of six, indicates that in the parental plants one of the pairs involved in translocation is common.

Plant 14-46-1, which showed an association of nine chromosomes in 1.3% of the PMCs (forked or a straight chain, Table 1, Fig. 1 l) was located in the progeny of a cross between two translocation heterozygotes, one forming an association of four chromosomes (female) and the other an association of six chromosomes, with one of the pairs involved in interchange in the two parents being common. The extra chromosome is a modified chromosome (*H F*) having homologies with three pairs involved in interchange (*f e, E d, D C, c a, A B, b F*) and another unaltered pair (*G H, g h*). Other higher associations involving eight to four chromosomes were found in 40.3% of the PMCs.

In these three plants, more complex configurations are possible but were not found.

The trisomics of this category were not on record earlier in pearl millet.

B chromosomes ranging from 0 to 5 were present in four of the plants (9-6-4, 17-6-8, 1-11-10, 15-8-6; Table 1, Fig. 1 c, d, e, g, k). Morphologically, the trisomic categories except the primary trisomics were not seemingly distinct from the diploid sibs and certainly could not be fit into any of the different trisomics described by Gill et al. (1970) and Manga (1976). They were generally very weak and produced 2–3 tillers. Pollen fertility and seed set were low, however, a few open pollinated seeds from each of the trisomics could be collected.

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