TERTIARY TRISOMICS IN PEARL MILLET

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Twelve different tertiary trisomics were isolated from the selfed progenies of single interchange heterozygotes in an inbred line, I-55, of pearl millet. Cytological analysis revealed that the configurations produced by the tertiary chromosome and related normal chromosomes presented the normally expected pattern.

INTRODUCTION

Tertiary trisomics are one of the most useful cytogenetic variants. In spite of their utility to determine the arm location of marker gene, position of centromeres, orientation of linkage maps and production of hybrid seed through the use of balanced tertiary trisomics, tertiary trisomics have been produced only in *Datura* (Avery *et al.* 1959), *Oenothera* (Catcheside 1954), tomato (Khush and Rick 1967; Reeves 1969), maize (Burnham 1930), barley (Ramage 1955, 1960), rye (Sybenga 1966) and pea (Muller 1975). The present communication reports on the production and cytological behaviour of tertiary trisomics in pearl millet, *Pennisetum typhoides* (Burm.), Stapf. and Hubb. ($2n=14$).

MATERIALS AND METHODS

Chromosomal interchange heterozygotes induced in an inbred line, I–55, of pearl millet (Singh and Tyagi 1973; Tyagi 1972, 1975; Tyagi and Singh 1974, 1975) were used for production of tertiary trisomics. Progenies of selfed interchange heterozygotes were sown in field. The off-type plants having short stature, thin stem and narrow leaves were marked. Young spikelets of these plants were fixed in Carnoy's solution (6 parts absolute ethyl alcohol, 3 parts chloroform and 1 part glacial acetic acid) saturated with Fe-acetate and anthers were squashed in acetocarmine. All analyzable pollen mother cells at diakinesis/metaphase I (MI) were scored according to the pairing patterns of the chromosomes.

Estimates were made of pollen fertility, based on the number of pollen grains stained by I_2KI. Only grains that were plump and full and took up the stain were counted as fertile.

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Observations and Discussion

Cytological examination revealed that out of 317 plants selected from the selfed progenies of 26 different single interchange heterozygotes, 33 were trisomics. Besides primary trisomic interchange heterozygotes, 12 tertiary trisomics were isolated.

Trisomics occur in the progeny of interchange heterozygote as a result of non-disjunction of the quadrivalent at anaphase I (A I). Such non-disjunction occurs when two of the chromosomes are cooriented and two non-cooriented, in the Metaphase I (M I) spindle (Hagberg 1954). In the absence of crossing-over in the interstitial segment, an interchange heterozygote on selfing can produce eight different trisomics. Of the eight kinds, four would be tertiary and four primary. Two of the tertiary trisomics would have a heterozygous background for the interchange and two, homozygous normal background. Similarly, two of the primary trisomics would have interchange background. The procedures for identifying the different kinds of trisomics expected from the progeny of a selfed interchange heterozygote have been discussed extensively by Ramage (1960).

A maximum association of five chromosomes is expected at diakinesis in a tertiary trisomic. Chiasma terminalization or failure of chiasma formation may, however, correspondingly reduce the association to such configurations as 1 IV+1 I, 1 III + 1II, 1 III+2 I, 2 II+1 I, 1 II+3 I, or 5 I. For each tertiary trisomic, from 86 to 572 cells were scored at diakinesis/M I. The percentage of cells falling into each of these association types are given in Table I for the 12 different tertiary trisomics. It is clear that the tertiary trisomics differ from each other in their ability to form pentavalents since some of the differences are statistically significant. The model configuration among the tertiary trisomics was 6 II+1 III, mean frequency 42.5 per cent (Fig. 5); and the next frequent class was 7 II+1 I, mean frequency 33.8 per cent (Fig. 1). The former resulted from pairing and chiasma formation between the extra interchanged chromosome and of the related homologous pairs, the latter probably from failure of such events. Chromosome association of 5 II+ 1 V (Figs. 2 and 3), 5 II+1 IV+1 I (Fig. 6), 5 II+1 III+2 I, 6 II+3 I and 5 II+ 5 I were rare, their mean frequencies being 11.4, 0.4, 9.1, 3.2 and 0.7 per cent, respectively.

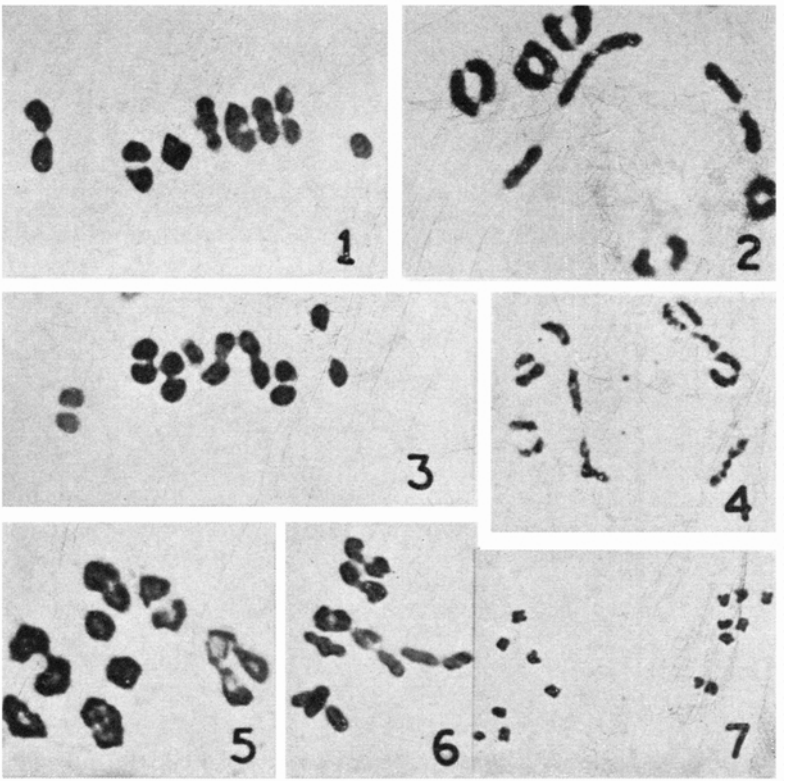
The pentavalent in a tertiary trisomic may assume six different types of configurations depending upon the number and position of chiasmata (Khush and Rick 1967). The critical configuration observed at diakinesis in all the 12 tertiary trisomics was dumb-bell shaped pentavalent—the two ring bivalents linked by an interchanged chromosome (Fig. 4) and the absence of ring quadrivalent. The dumb-bell shaped pentavalent configuration requires at least six chiasmata, both sets of three homologous arms must form at least two chiasmata apiece, thus accounting for the observed rarity of this type in each of the tertiary trisomics studied. The two configurations, i.e., 5 II+1 V and 5 II+1 IV+1 I have nearly the same degree of attraction between the tertiary chromosome and the normal complement, they probably differ only in chiasma formation.

The type of chromosome distribution at A I and their frequencies are given in Table II. At A I 8 : 7 distribution was predominant, 85.2 per cent, (Fig. 7). Irregularities like late separation of bivalents, chromatin bridge formation, 7–1–7 and

TABLE I

Pollen fertility and meiotic behaviour of tertiary trisomics

Culture and plant number	Pollen fertility (%)	No. of cells scored	Frequencies of chromosomal associations at diakinesis/ M I given in % of cells analysed						
			5 II + 1 V	5 II + 1 IV + 1 I	6 II + 1 III	5 II + 1 III + 2 I	7 II + 1 I	6 II + 3 I	5 II + 5 I
T 1—18	76.3	475	20.2	1.7	49.6	2.7	24.7	1.1	0.0
T 2—21	69.9	319	25.1	0.0	58.6	0.9	14.8	0.6	0.0
T11— 2	75.1	134	20.1	1.5	47.8	0.0	30.6	0.0	0.0
T23—19	40.5	220	6.8	0.0	41.7	4.5	47.0	0.0	0.0
T23—74	59.7	285	5.9	0.0	40.7	13.0	37.9	0.7	1.8
T24— 1	71.3	572	7.1	0.0	55.6	11.1	24.7	1.5	0.0
T41— 7	23.7	315	1.3	0.0	35.1	0.0	63.6	0.0	0·0
T46—29	20.2	86	7.0	0.0	59.5	3.5	30.0	0.0	0.0
T50—41	62.4	298	5.6	0.0	6.9	33.2	35.7	18.6	0.0
T51— 3	88.3	234	2.6	0.0	17.9	33.7	24.4	14.1	7.3
T51— 9	72.9	314	15.3	0.6	66.2	0.0	17.9	0.0	0.0
T55—20	37.2	213	4.7	0.0	30.4	7.1	55.4	2.4	0.0
Average	58.1	288	11.4	0.4	42.5	9.1	33.8	3.2	0.7



FIGS. 1 to 7. Meiotic chromosome configurations of tertiary trisomics in pearl millet. 1, M I showing 7 II+1 I; 2, Diakinesis showing 5 II+1 V; 3, M I showing 5 II+1 V; 4, Diakinesis showing 5 II+1 V (dumb-bell shaped); 5, M I showing 6 II−1 III; 6, M I showing 5 II+1 IV+1 I; 7, A I showing 8:7 separation of chromosomes.

TABLE II

Distribution of chromosomes at A I of meiosis in tertiary trisomics

Culture and plant number	No. of cells scored	Distribution of chromosomes given in % of cells analysed		
		8:7	7–1–7	6–2–7
T 1–18	115	89.6	8.7	1.7
T 2–21	122	90.2	5.7	4.1
T11– 2	140	92.1	6.4	1.4
T23–19	76	94.7	5.3	0.0
T23–74	50	62.0	16.0	22.0
T24– 1	210	92.0	7.1	0.9
T41– 7	82	96.2	3.8	0.0
T46–29	103	95.1	4.0	0.9
T50–41	54	77.9	14.8	7.3
T51– 3	39	48.7	28.2	23.1
T51– 9	73	87.7	12.3	0.0
T55–20	112	96.4	2.7	0.9
Average	98	85.2	9.6	5.2

6–2–7 distribution of chromosomes were also found.

Pollen fertility in tertiary trisomics ranged from 20.2 to 88.3 per cent with a mean value of 58.1 per cent (Table I). The tertiary trisomics were distinct phenotypically pointing to differences in the tertiary chromosome involved in each of the trisomics.

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