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ON THE DEVELOPMENT OF A NEW SET OF PRIMARY TRISOMICS IN AN INDIAN MAIZE

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ABSTRACT

In the triploid x diploid crosses of maize (*Zea mays* L.) the plump, semiplump, shrivelled and fluffy kernels had 42.7, 25.5, 12.0 and 0% survival, respectively. The kernel categories showed difference in chromosome number variation pattern. The plump kernels contained 23.4% trisomics, whereas the semiplump and shrivelled kernels contained 10.8% and 3.3% trisomics, respectively. Karyotype analysis revealed that any extra chromosome can be transmitted through the female gamete of the triploid and thus it will be possible to identify different primary trisomics from the plump kernels of triploid x diploid crosses or its progeny.

Key words: Maize, triploid x diploid crosses, primary trisomics.

The primary trisomics, having an extra chromosome of its normal complement, provide an excellent cytogenetic tool in plant species. It is useful in location of genes on chromosomes, identification of chromosomes involved in interchanges, study of differential affinity of chromosomes in pairing, studies on gene and chromosome dosage effects, etc. [1, 2]. The available primary trisomics of maize (*Zea mays* L.) are not adapted to Indian conditions and hence it was required to develop new primary trisomics in well adapted genetic backgrounds.

MATERIALS AND METHODS

The Alexander's Synthetic B tetraploid (2n = 4x = 40) stock of maize was crossed with a diploid (2n = 2x = 20) inbred line either as male or female parent to obtain triploids (2n = 3x = 30). The kernels from these crosses were categorised as plump (normal bold), semiplump (fully developed with slight shrivelling), shrivelled (partially developed with little endosperm), and fluffy (paper thin, almost devoid of endosperm). These kernels were

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sown in field and data on plant survival recorded at flowering. The triploid plants were crossed with diploids and the resultant cobs were analysed for kernel development. These kernels were also planted and either selfed or crossed with diploid lines. The chromosome number of the kernels in the triploid x diploid crosses were determined in root tip squashes. The somatic karyotype analysis was done to identify the extra chromosomes present in the trisomics.

RESULTS AND DISCUSSION

The kernels from tetraploid x diploid reciprocal crosses had varying survival percentage (Table 1). All the fluffy kernels from 4x x 2x crosses analysed were triploids with the chromosome number 2n = 30. Out of the 23 shrivelled kernels analysed, 19 were 2n = 30, two with 2n = 28, and one each with 2n = 27, 32 and 38. The plump and semiplump kernels from these crosses are not favoured to be grown for raising triploids as the chance of these being the products of contamination is high [3]. In the (4x x 2x) x 2x crosses, the survival percentage of plants from plump, semiplump and shrivelled kernels was 42.7, 25.7 and 12.0, respectively, and the fluffy kernels did not germinate.

Table 1. The distribution of different kernel categories in 4x x 2x and 2x x 4x crosses of maize (percentage of plant survival given in parentheses)

Cross	No. of cobs	Kernel frequencies				Total kernels
		plump	semiplump	shrivelled	fluffy	
4x x 2x	119	41 (59.09)	118 (37.93)	1217 (18.60)	9042 (1.56)	10418
2x x 4x	116	57 (-)	57 (-)	2653 (0.40)	9200 (0.06)	11967

The kernel categories from 3x x 2x crosses showed difference in chromosome number variation pattern (Table 2). The percentage of trisomics (2n = 21) were 23.5, 10.8 and 3.3, respectively, in the plump, semiplump and shrivelled kernels. Primary trisomics, except for chromosomes 6 and 8, were identified from among the plump kernels of 3x x 2x crosses after karyotype analysis. Kernels with more than 21 chromosomes had extra chromosomes 6 and 8. It indicated the possibility of getting all the primary trisomics from the plump kernels of 3x x 2x crosses if a large number of plants were analysed. There was no preferential occurrence of extra chromosomes in the plump and shrivelled kernels (Table 3). In the progeny of eleven plants from (3x x 2x) x 2x crosses studied, only five plants had trisomics. Primary trisomics 1, 4 and 5 were obtained from one such progeny. One out of the five progenies from (3x x 2x) selfed, had primary trisomics. Hence the different primary trisomics can be obtained from among the progeny of hyperdiploid plants.

Table 2. Chromosome number of 3x x 2x plants from different kernel categories

Chromosome number (2n)	Plump kernels		Semiplump kernels		Shrivelled kernels		Total kernels analysed
	No. of plants	% of total	No. of plants	% of total	No. of plants	% of total	
20	6	7.41	1	2.70	0	0.00	7
21	19	23.46	4	10.81	2	3.33	25
22	33	40.74	6	16.22	7	11.67	46
23	15	18.52	16	43.24	10	16.67	41
24	2	2.47	8	21.62	17	28.33	27
25	4	4.94	1	2.70	16	26.67	21
26	1	1.23	1	2.70	5	8.33	7
27	0	0.00	0	0.00	2	3.33	2
28	1	1.23	0	0.00	1	1.67	2
Total	81		37		60		178

McClintock [4] reported that 14% plants from 3x x 2x crosses were primary trisomics in maize. In a later study [5], the small kernels from 2x x 3x crosses had 38.06% trisomics and the large kernels from 3x x 2x crosses had 27.58% trisomics. It is not known whether all the chromosomes can be transmitted as extra through the pollen in the 2x x 3x crosses. Screening of small kernels from inbred ears was suggested as a method to develop primary trisomics in uniform genetic backgrounds [6], but due to varying kernel weight all the primary trisomics cannot be isolated from small kernels only [7, 8]. The different genetic backgrounds of the source population can also influence kernel weight in primary trisomics of maize. Lin and Coe [9] found that r-x1 deletion in chromosome 10 produces primary trisomics by nondisjunction of chromosomes during embryo sac development, but it was not reported whether all the primary trisomics could be obtained by that method.

Table 3. Summary of karyotype analysis of plump and shrivelled kernels from 3x x 2x crosses

Kernel category	No. of kernels analysed	No. of plants with varying No. of extra chromosomes										Total extra chromosomes in each category
		1	2	3	4	5	6	7	8	9	10	
Plump	23	5	2	7	6	3	1	4	4	8	7	47
Shrivelled	11	8	7	8	3	2	1	4	2	6	5	46

In this study, it was found that any extra chromosome can be transmitted through the female gamete in the 3x x 2x crosses of maize. The plump kernels from 3x x 2x crosses had high frequency of 2n=21 plants and such kernels had high survival also. Thus, it will be

convenient to isolate primary trisomics from plump kernels of 3x x 2x crosses or its progeny. The trisomics and their disomic sibs did not have distinct morphological differences by which a particular trisomic could be distinguished, contrary to some earlier reports [10]. The primary trisomics with different genetic background may have difference in the effect of extra chromosome on morphology [11]. By karyotype analysis from the root tip cells, the different primary trisomics can be separated from among the 2n = 21 plants.

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