Chromosome Number Variation among Germplasm Collections and Seedling Progenies in Turmeric, Curcuma longa L

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Chromosome Number Variation among Germplasm Collections and Seedling Progenies in Turmeric, *Curcuma longa* L.†

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Summary Chromosme numbers in 22 germplasm collections and 28 open-pollinated seedling progenies of turmeric (*Curcuma longa* L.) were determined by counting the chromosomes of somatic metaphase plates. Among the germplasm collections analyzed 20 have $2n=63$, the accepted chromosome number of turmeric, 1 collection was $2n=61$ and another 1 was $2n=84$. The seedling progenies showed various chromosome numbers ranging from $2n=63$ to $2n=86$, of which $2n=84$ was the most frequent. The role of abnormalities during triploid chromosomes segregation in generating chromosome number variation among open pollinated seedling progenies is discussed.

Key words *Curcuma longa*, Turmeric, Variation of chromosome number, Gerplasm collection.

Turmeric (*C. longa* L., Zingiberaceae) is a tropical perennial herb cultivated widely in India and its underground rhizomes are used as a condiment, dye, drug and cosmetic, after processing and value addition. Turmeric is a certified natural food colour and has several uses in traditional Indian medicine as well as modern medicines for various human ailments (Govindarajan 1980, Purseglove *et al.* 1981, Pruthi 1998, Chattopadhyay *et al.* 2004, Ravindran *et al.* 2007). The chromosome number of *C. longa* $2n=63$ was reported frequently (Chakravorti 1948, Ramachandran 1961, 1969, Nambiar 1979, Renjith *et al.* 2001, Nair 2000). Deviations such as $2n=32$ (Sato 1948), $2n=48$ (Das *et al.* 1999), $2n=62$ (Raghavan and Venkatasubban 1943, Sharma and Bhattacharya 1959), $2n=64$ (Chakravorti 1948) and $2n=84$ (Renjith *et al.* 2001) have also been reported. The basic chromosome number of the genus *Curcuma* is suggested as $x=21$ which in turn originated by dibasic amphidiploidy from $x=9$ and $x=12$ or by secondary polyploidy (Ramachandran 1961, 1969, Nambiar 1979). Turmeric has been considered as a triploid and pollen fertility is less than 60% (Nambiar 1979, Nair *et al.* 2004). Even though it was believed earlier that *C. longa* fails to set seeds unlike *C. aromatica* (Nambiar 1979, Nazeem *et al.* 1994), seed set and germination of seeds have recorded (Lad 1993, Sasikumar *et al.* 1996, Nair *et al.* 2004). High yielding varieties also have been emerged as a result of yield and quality evaluation of open pollinated progenies of turmeric (Sasikumar *et al.* 1996). However, information regarding the chromosome number of seedling of progenies of turmeric is lacking. Only very few reports are available on the chromosome number of *C. longa* collections (Renjith *et al.* 2001). In the present study, an investigation on chromosome number in germplasm collections and open pollinated seedling progenies of turmeric is attempted.

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Table 1. Chromosome number in germplasm collections of turmeric

Acc No	Chromosome number (2*n*)
11	63
18	63
20	63
21	63
23	63
26	63
28	63
30	61*
32	63
40	63
43	63
50	63
65	63
69	63
126	63
136	63
138	63
260	63
300	84*
312	63
324	63
326	63

* Variations from normal chromosome number.

Table 2. Chromosome number variation in turmeric seedling progenies

SLP No.	Chromosome number (2*n*)
23a	84
23b	84
360 (Prabha)	63
384	63
399	63
414	86
415	84
417	84
426	78
434	63
435	63
449	84
473	63
715	77
716	84
718	68
719	74
721	84
722	84
723	84
724	78
725	84
727	84
730	63
767	63
768	80
770	72
782	78

Materials and methods

Plant materials

Rhizomes of 22 germplasm collections and 28 seedling progenies of turmeric, *C. longa* harvested and stored at the germplasm repository of the Indian Institute of Spices Research, Calicut, India were used for the study.

Cytological analysis

The rhizomes were planted in seed pans filled with clean river sand and regularly watered. On initiation of sprouting and root emergence, root tips were collected for analysis. Actively growing root tips from the freshly emerging roots of 5–10 mm length were collected between 11.00 and 11.30 AM and pretreated with a 1 : 1 mixture of saturated paradichlorobenzene solution and 2 mM 8-hydroxyquinoline at 4–5°C for 4 h. After washing thoroughly in double distilled water, the root tips were fixed in a mixture of ethyl alcohol and propionic acid (3 : 1) for 24 h.

The fixed root tips were subjected to hydrolysis with 5 M HCl at 0°C for 4 min and stained in 2% lactopropionic orcein for 4 h, and then squashed in 45% propionic acid. Photomicrographs were taken from temporary slides using a Leica DBRB microscope fitted with MPS-28 camera. 6 mitotic metaphase plates with good chromosome spread from 2–3 slides were used for counting the chromosome number in each plant.

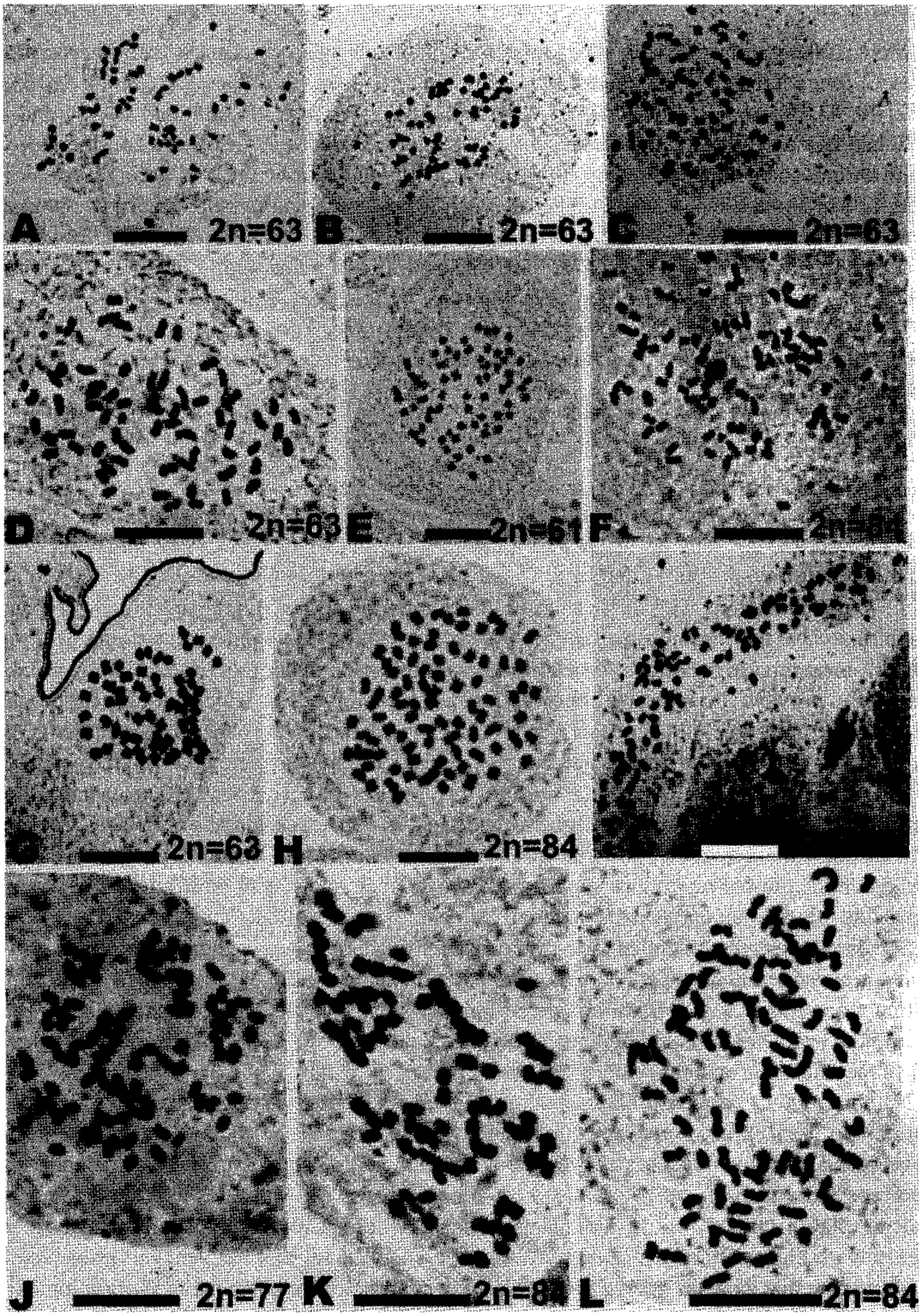

Fig. 1. Somatic metaphase chromosomes in germplasm collections (A–F) and seedling progenies (G–L) of turmeric. A. Acc. No. 11 ($2n$=63), B. Acc. No. 23 ($2n$=63), C. Acc. No. 26 ($2n$=63), D. Acc. No. 138 ($2n$=63), E. Acc. No. 30 ($2n$=61), F. Acc. No. 300 ($2n$=84), G. SLP No. 384 ($2n$=63), H. SLP No. 23b ($2n$=84), I. SLP No. 414 ($2n$=86) J. SLP No. 715 ($2n$=77), K. SLP No. 721 ($2n$=84), L. SLP No. 727 ($2n$=84). Bars represent 5 μm.

Results

Most of the germplasm collections analyzed showed $2n=63$, the accepted chromosome number for *C. longa*. Of the 22 collections analyzed, 20 had $2n=63$ (Acc. Nos. 11, 18, 20, 21, 23, 26, 28, 32, 40, 43, 50, 65, 69, 126, 136, 138, 260, 312, 324, 326), Acc. No. 300 had $2n=84$ and Acc. No. 30 had $2n=61$ (Table 1). Conversely, the seedling progenies (SLPs) showed a considerable variation in chromosome number ranging from $2n=63$ to $2n=86$. Among the 28 seedling progenies analyzed, 11 had $2n=84$, 8 had $2n=63$, 3 had $2n=78$ and 1 of each had $2n=68$, 72, 74, 77, 80 and 86. The SLPs with $2n=84$ were 23a, 23b, 415, 417, 449, 716, 721, 722, 723, 725, 727; $2n=63$ were 360 (Prabha), 384, 399, 434, 435, 473, 730, 767 and $2n=78$ were 426, 724, 782. Chromosome numbers of other seedling progenies were SLP No. 718-$2n=68$; 770-$2n=72$; 719-$2n=74$; 715-$2n=77$; 768-$2n=80$ and 414-$2n=86$ (Table 2). Mitotic metaphase plates showing chromosome numbers of a few germplasm collections are presented in Fig. 1A–F and those of seedling progenies are presented in Fig. 1G–L.

Discussion

The chromosome number observed among the majority of germplasm collections in the present study was $2n=63$. The occurrence of a collection with $2n=84$ (ACC. No. 300) supports the finding of Renjith *et al.* (2001) that in *C. longa* cultivars with $2n=63$ as well as $2n=84$ are available. *C. longa* collections with $2n=61$ has not been reported so far. Being vegetatively propagated through rhizomes, the chromosome number in turmeric will be stable, unless interfered by a sexual process or rare somatic mutations. Variations in chromosome number in a triploid like turmeric are more easily possible through the intervention of sexual process which results in progenies with varied chromosome numbers as a result of triploid segregation. Therefore, the present collections with $2n=84$ and $2n=61$ might have originated from normal turmeric ($2n=63$) through natural seed propagation. The earlier opinion that triploid *C. longa* will not set seed (Ramachandran 1961) is not acceptable in view of the subsequent reports (Lad 1993, Sasikumar *et al.* 1996, Nair *et al.* 2004). Besides, the numerical variation of chromosomes among the seedling progenies discussed elsewhere in the present report also supports the above view. Analysis of more cultivars of *C. longa* will provide information on the distribution of different cytotypes among the cultivated turmeric.

Seedling progenies exhibited extensive variation in chromosome number (Table 2). All the seedling progenies analyzed were derived from parent plants with $2n=63$, the chromosome number variation might have resulted from the union of gametes with varied chromosome numbers resulted from triploid segregation. Polyploids with odd number of genomes like triploids exhibit higher degrees of meiotic abnormalities (Gupta 1997).

Nambiar (1979) observed that meiosis in *C. longa* exhibited varying degrees of chromosome abnormalities and chromosome associations. Quadrivalents, trivalents, bivalents and univalents were recorded in varied frequency depending on the cultivar. In general, however, the number of bivalents was more than the other chromosome configurations. This indicates that the trivalents and univalents play a crucial role in producing gametes with variable chromosome number thereby progenies with higher chromosome numbers than $2n=63$. The highest frequency of progenies with $2n=84$ indicate that gametes having $n=42$ may have some selective advantage. As variation in meiotic configuration between cultivars has been reported (Nambiar 1979), it will be more informative to analyze a large number of seedling progenies of different cultivars of turmeric. A comparison of chromosome numbers of seedling progenies of germplasm collections having $2n=84$ with the progenies of collections having $2n=63$ will provide information on the genomic stability of former, compared to latter.

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