

CHROMOSOMAL RACES OF *THEMEDA ANATHERA* FROM PAKISTAN

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Abstract

Chromosome number and meiotic pairing of three varieties of *Themeda anathera* (Nees) Hack. from Pakistan show diploids, aneuploids and euployploids all with regular meiosis and bivalent formation. No cytological difference between the varieties was found. It is argued that chromosomal pairing is gene controlled which has promoted the survival of polyploids. Furthermore, the survival of aneuploids is detremined phylogenetically within the genome of the species.

Introduction

The genus *Themeda* includes about 20 species distributed in the warm parts of Africa, Asia and Australia. Among these *T. triandra* covers a large area in the tropical and the southern parts of Africa in particular and warm parts of the old world in general. This species is regarded as the best natural grazing grass of the world (Pienaar, 1955). Another species, *T. australis*, shows a very wide distribution in the subtropic and temperate regions of Australian grassland as a dominant species (Hayman, 1960). The remaining species of *Themeda* are distributed mainly in India and south-east Asia.

In Pakistan the genus *Themeda* is represented by a single species *T. anathera*, which extends from sub-tropics to the temperate zones of Pakisan as well as India. Interestingly enough all the three widely distributed species, i.e. *T. triandra*, *T. australis* and *T. anathera* show polyploidy as well as aneuploidy (Mehra, 1955; Pienaar, 1955; Raman *et al.*, 1959; Faruqi *et al.*, 1979). Moreover B-chromosomes are also reported in some species belonging to this genus (Birari, 1981). Chromosomal variation with the genus *Themeda* in general and both chromosomal as well as morphological variation in *T. anathera* in particular made this species interesting for further investigations.

Material and Methods

Plants of *Themeda anathera* (Nees) Hack., from different locations of Pakistan were grown in the uniform nursery of the Department of Genetics, University of Karachi. Methods of collection and cytological preparations were the same as given earlier (Quraish & Faruqi, 1979).

Results

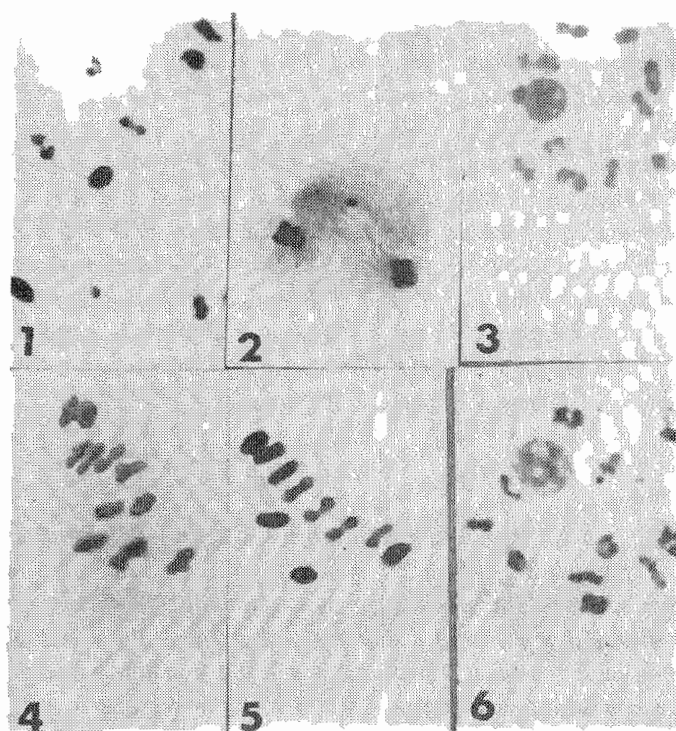
Themeda anathera is a perennial grass with erect or geniculately ascending stem. Racemes are solitary, consisting of a few pairs of spikelets in two superimposed series, with the lower four spikelets forming an involucre. Involucral spikelets are persistent, the bisexual ones deciduous and the sessile spikelets are not awned. There is considerable variation with respect to the number of tillers per plant, height as well as leafiness. Variation of pubescence on the lower glume of involucral spikelet divides *T. anathera* into three varieties locally. Lower glumes of the involucral spikelets are glabrous in var. *glabrescens*, sub-marginally pubescent with bulbous-based hairs in var. *submarginata* and hispidly ciliate with tubercle-based hairs in var. *hirsuta*. Although these varieties do not show clear cut differences, yet their names are maintained arbitrarily in this paper to see if these morphological differences show any correlation with cytology.

Cytologically in var. *glabrescens* $n = 10 + 1$ frag., 13 and 20 chromosomes were recorded (Table 1). In the tetraploid plant with $n = 20$ chromosomes, a maximum of 2 quadrivalents was observed. On the other hand, the diploid plant with $n = 10 + 1$ frag. and the aneuploid with $n = 13$ chromosomes showed only regular bivalent formation but the fragment did not pair with any chromosome (Fig. 1) and in telophase I it was observed as laggard (Fig. 2).

Variety *hirsuta* included diploids with $n = 10$ and $10 + 1$ frag., aneuploids with $n = 11$ and hexaploid with $n = 30$ chromosomes (Table 1). Except in plant number 2866 where a maximum of one trivalent was observed (Fig. 3), the rest of the plants showed regular bivalents or occasionally some univalents in metaphase I. It is important to note that in each case most of the cells showed 100 percent bivalent formation (Fig. 4; Table 2 see the frequency of bivalents).

Table 1. Chromosome number and behavior in *Themeda anathera* var. *glabrescens*.

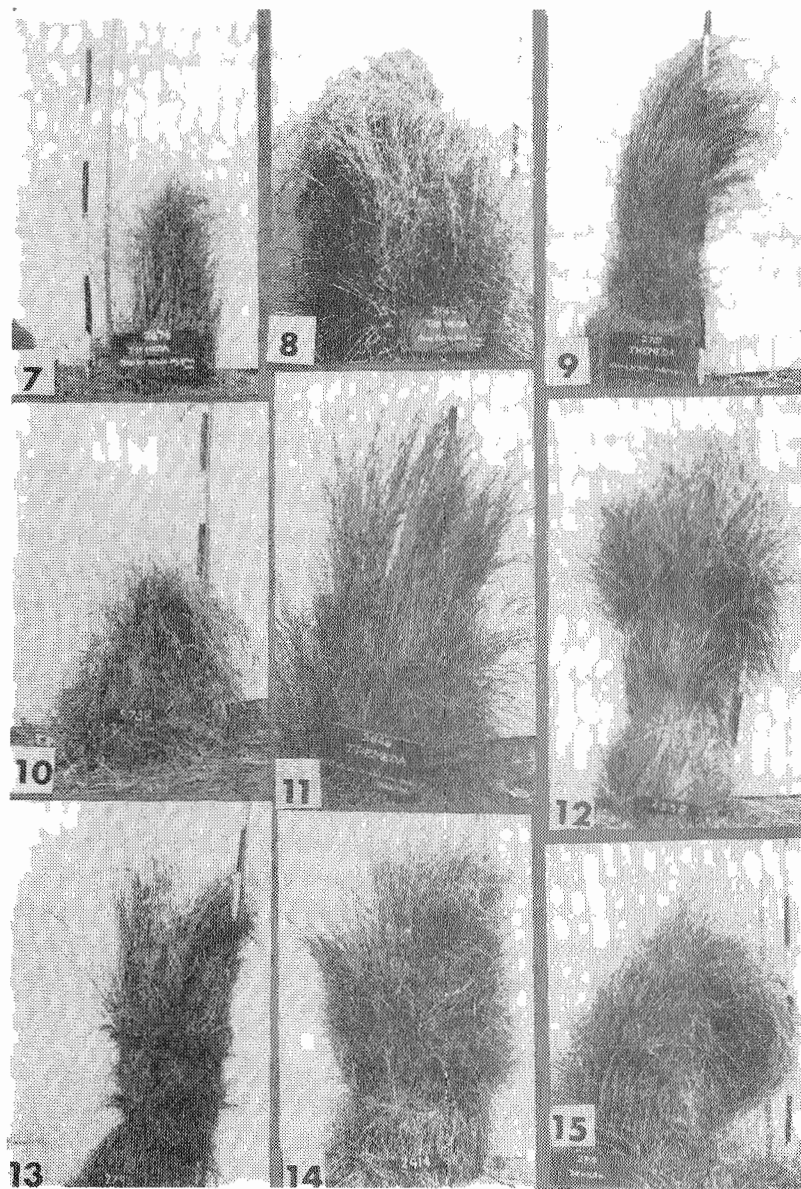
Acc. No.	Locality	n	Frequency				Range			
			I	II	III	IV	I	II	III	IV
2538	Sakesar	20	0.8	18.4	—	0.6	0-2	15-20	—	0-2
2610	Sargodha Jhelum area	10 +1 frag.	0.45	9.77	—	—	0-2	9-10	—	—
2751	Naseri, 38 miles from Aath Moqam, Azad Kashmir	13	1.5	12.25	—	—	0-2	12-13	—	—



Figs. 1-6. *Themeda anathera* showing: Fig. 1. var. *glabrescens* with 10 bivalents and 1 fragment in telophase II; Fig. 2. var. *glabrescens* with 10 bivalents and 1 fragment in telophase II; Fig. 3. var. *hirsuta* with 9 bivalents and 1 trivalent in diakinesis; Fig. 4. var. *hirsuta* with 11 bivalents in metaphase I; Fig. 5. var. *submarginata* with 10 and Fig. 6. 11 bivalents in diakinesis.

Table 2. Chromosome number and behavior in *Themeda anathera* var. *hirsuta*.

Acc. No.	Locality	n	Frequency				Range			
			I	II	III	IV	I	II	III	IV
2953	Kallar Kahar	10	0.33	9.83	—	—	0.4	8-10	—	—
2594	Kallar Kahar	11	0.36	10.81	—	—	0.2	10-11	—	—
2595	Kallar Kahar	10	0.34	9.82	—	—	0.6	7-10	—	—
2674	Chinari, Azad Kashmir	10	0.44	9.77	—	—	0.2	9-10	—	—
2759	Gojra, 2 miles from Mozaffarabad	10+ 1 frag.	0.29	9.85	—	—	0.4	8-10	—	—
2866	Garhi Habibullah	11	1.30	10.23	0.07	—	0.2	9-11	0-1	—
2910	8 miles from Nathiagali towards Abbotabad	30	0.66	29.66	—	—	0.2	29-30	—	—



Figs. 7-15. *Themeda anathera* showing variation in height and luxuriance: Fig. 7. var. *hirsuta* (2674) with $n = 10$ chromosomes; Fig. 8. var. *glabrescens* (2610) with $n = 10$ and Fig. 9. (2751) $n = 13$ chromosomes; Fig. 10. var. *submarginata* (2738) with $n = 10$ chromosomes; Fig. 11. var. *hirsuta* (2866) with $n = 11$ chromosomes; Fig. 12. var. *glabrescens* (2538) with $n = 20$ chromosomes; Fig. 13. var. *submarginata* (2793) with $n = 10$ and Fig. 14. (2914) 11 chromosomes; Fig. 15. var. *hirsuta* (2910) with $n = 30$ chromosomes.

Reduced or unreduced female gametes, with or without one or more additional chromosomes may be fertilized with a reduced or unreduced male gamete. Such fertilizations have resulted in the production of diploids, aneuploids and eupolyploids within the same population (Table 2; Plant nos. 2593, 2594 and 2595).

It is interesting to note that all aneuploids except one (Table 2; Plant no. 2866) have regular bivalents at diakinesis as well as metaphase I with few and occasional univalents. Likewise, all the eupolyploids have regular bivalent formation. The aneuploids with $n = 11$ and 13 chromosomes, at diploid level carry one and three sets of four homologous chromosomes, respectively. Consequently, one would expect one or three trivalents at metaphase I, at least in some cells of these plants. But as mentioned earlier, this is not the case, and only one aneuploid was found with a trivalent. Similarly, the tetraploid and hexaploid plants also, show a regular bivalent formation. It is important to note that these eupolyploids have originated with the populations of a single species and they have a repeat of the same genome four or six times respectively. This indicates gene controlled pairing of chromosomes in *T. anathera*. Also, it shows that how in one step an autopolyploid starts behaving as a true allopolyploid. This substantiates our earlier view, that gene controlled pairing of chromosomes is of significant importance in the promotion of polyploidy in those plants where parental genomes are either similar or only partially differentiated (Faruqi, 1972, Quraish & Faruqi, 1979, Faruqi & Quraish, 1985).

Presence of aneuploidy in *T. anathera* along with African *T. triandra* and Australian *T. australis* is quite interesting (Mehra, 1955; Pienaar, 1955; Raman *et al.*, 1959; Hayman, 1960; de Wet, 1960; Faruqi *et al.*, 1979; Birari, 1981). It shows the capability of these species to survive with an unbalanced genome. For example in *Dichanthium intermedium* complex aneuploids are known to originate quite frequently under nursery conditions (Chheda *et al.*, 1961). However, among hundreds of chromosome counts of this complex not a single aneuploid was found in nature (Celarier, 1957; Celarier & Harlan 1958; Mehra, 1961; de Wet & Higgins, 1963; Faruqi 1964; Faruqi *et al.*, 1979).

Apomixis as the reason for the absence of aneuploidy in the natural populations of *D. intermedium* complex as given by Chheda *et al.*, (1961) can not be accepted. This is because both eupolyploidy and aneuploidy is quite common in the three apomictic species *T. anathera*, *T. triandra* and *T. australis*. Thus the absence of aneuploidy in *Dichanthium* and its presence in *Themeda* shows that their elimination or survival in nature is determined phylogenetically within their respective genomes.

Acknowledgement

This study was financed by the U.S.D.A. under the P.L. 480 research grant for which the authors are thankful.

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(Received for publication 15 February 1987)