Pachytene Chromosomes of *Pennisetum typhoides*

K. S. Lobana and B. S. Gill¹

Department of Genetics, Punjab Agricultural University,
Ludhiana, India

Received June 8, 1972

Since the first report of McClintock (1929) standardising the morphology of maize chromosomes at pachytene, a number of workers have reported detailed idiograms in various crop species on the basis of pachytene chromosomes. Pantulu (1958) reported that 7 haploid chromosomes of *Pennisetum glaucum* (Syn.: *P. typhoides*) could be distinguished on the basis total length of the chromosomes and the position of the centromeres at pachytene. Venkateswarlu and Pantulu (1968) identified pachytene chromosomes in *Pennisetum typhoides* and numbered them 1 to 7 in order of their decreasing lengths. In our laboratory for the identification of trisomic and translocation stocks in *Pennisetum typhoides* a need was felt to construct a standard idiogram based on pachytene chromosomes of inbred BIL-4 which has been used for the development of these stocks. The results obtained are presented in this paper.

Material and methods

The pollen mother cells of an inbred BIL-4 of *Pennisetum typhoides* (Burm.) S. and H. were fixed in acetic alcohol (1:3). Anther smears were made in two per cent acetocarmine. All pachytene cells studied were photographed from temporary slides and measurements of the chromosomes were made from the enlargements using a pair of divider set. Total length (actual length in micron), relative length (absolute length expressed as the percentage of total complement length), location of centromere and arm ratio (length of short arm/long arm) were taken. The length of the satellite was included in the concerned arm. After identification of the individual chromosomes, these were numbered from 1 to 7 in descending order of their length. A standard karyotype was prepared in the form of an idiogram on the basis of mean values. The heterochromatic and euchromatic regions were shown as broad and narrow lines respectively.

Observations

Five cells with well spread chromosomes were used for detailed studies. Figures 1 and 2 show photographs and interpretative drawing of one of these cells with centromeres indicated by an arrow. The information collected from these five

¹ Advisor Plant Breeding, F.A.O. of U.N., Caixa Postal 351, 99.100, Passo Fundo, R. S., Brazil.

cells was used to identify such chromosomes in other cells which could be followed throughout their length. The mean lengths of short arm and long arm, total length, relative length and arm ratios were calculated for each chromosome and are given in Table 1.

Figs. 1-2, 1, pachytene chromosomes of *Pennisetum typhoides*, $\times 1444$. 2, interpretative drawing of the pachytene cell of Fig. 1.

Table 1. Mean length, relative length and arm ratio of pachytene chromosomes of pearl millet inbred BIL-4

Chromosome number	No. of chromosomes measured	Total length (micron) $\pm$ S.E.	Relative length (per cent)	Short arm length (micron) $\pm$ S.E.	Long arm length (Micron) $\pm$ S.E.	Arm ratio
1	12	48.41 $\pm$ 2.44	19.13	19.11 $\pm$ 1.00	29.30 $\pm$ 1.45	0.65
2	10	42.26 $\pm$ 2.61	16.70	17.87 $\pm$ 1.04	24.39 $\pm$ 1.58	0.73
3	12	39.05 $\pm$ 2.18	15.43	18.39 $\pm$ 0.98	20.66 $\pm$ 1.21	0.89
4	6	38.01 $\pm$ 2.84	15.02	14.62 $\pm$ 0.81	23.38 $\pm$ 1.89	0.63
5	6	32.25 $\pm$ 0.58	12.75	12.26 $\pm$ 1.40	19.99 $\pm$ 2.73	0.61
6	10	28.25 $\pm$ 1.51	11.16	10.30 $\pm$ 0.58	17.59 $\pm$ 0.95	0.57
7	8	24.76 $\pm$ 2.31	9.78	5.45 $\pm$ 0.50	19.31 $\pm$ 1.86	0.28

S.E.—Standard error.

A standard karyotype as depicted in Fig. 3 was prepared. The distinguishing morphological features of each of the seven chromosomes in the haploid complement of *P. typhoides* are presented below.

Chromosome no. 1: This was the longest chromosome of the complement measuring on an average 48.41 micron and had a relative length of 19.13 per cent. It has a submedian centromere with an arm ratio of 0.65. The short arm terminates with a heterochromatic region and the long arm with lightly stained euchromatic region.

Chromosome no. 2: It was the second longest chromosome in the complement measuring on an average 42.26 micron with the relative length of 16.70 per cent.

It has a submedian centromere with an arm ratio of 0.73. Short arm was found to terminate with lightly stained euchromatic region, while the long arm had heterochromatic region at the terminal.

Chromosome no. 3: This chromosome measured 39.05 micron in length and had a relative length of 15.43 per cent. It has a median centromere with an arm ratio of 0.89. Both the arms terminate with euchromatic region. This chromosome is characterised by four prominent heterochromatin segments i.e. two in each arm.

Chromosome no. 4: It measured on an average 38.01 micron and had a mean relative length of 15.02 per cent. It had a submedian centromere with an arm ratio of 0.63. Short arm had approximately three-fourth heterochromatic segment while in long arm only one-third portion was heterochromatic.

Chromosome no. 5: This chromosome measured 32.25 micron and had a relative length of 12.75 per cent. It has a submedian centromere with an arm ratio of 0.61. The terminal end of long arm was heterochromatic while that of short arm was euchromatic. Short arm except a small segment was euchromatic whereas long arm had got equal proportions of heterochromatic and euchromatic regions.

Chromosome no. 6: It measured 28.25 micron and had a relative length of 11.16 per cent. It has a submedian centromere with an arm ratio of 0.57. Entire short arm was deeply stained. The short arm being entirely heterochromatin and termination of its long arm in euchromatic region make this chromosome easily distinguishable.

Chromosome no. 7: It is the nucleolus organizer and shortest chromosome of the complement. The nucleolus organizing region was almost at the terminal end of the short arm. The association of this chromosome with the nucleolus at pachytene provided a constant check for its identification. This chromosome on an average measured 24.76 micron with relative length of 9.78 per cent. It had a subterminal centromere with an arm ratio of 0.28. The short arm was completely heterochromatic. Termination of long arm is of euchromatic in nature.

Fig. 3. An idiogram of the pachytene chromosomes. A_S: short arm length, R: arm ratio, A_L: long arm length, T: total length.

Discussion

The chromosome length varied from 24.76 micron for the shortest to 48.41 micron of the longest. Venkateswarlu and Pantulu (1968) reported the shortest chromosome of *P. typhoides* to be 30.54 micron and the longest 54.21 micron. The heterochromatic knobs were not observed in the species. Four prominent intermitant heterochromatic segments in chromosome No. 3, two in each arm and termination of both ends in euchromatic nature distinguishes it from chromosome No. 2 and chromosome No. 4. In case of chromosome No. 2, long arm and short arm termination is of heterochromatin and euchromatin pattern respectively while in chromosome No. 4 major portion of the short arm is of heterochromatic and also end of the long arm is of heterochromatic segment which is shorter than the distal heterochromatic segment of chromosome No. 2. In chromosome No. 5, except the termination of long arm which is of heterochromatic fashion, the whole chromosome is of euchromatic in nature. Major portion of chromosome No. 6 is of heterochromatic in nature and termination of long arm is of euchromatic pattern. It is just the reverse of chromosome No. 5. Chromosome No. 7 can be distinguished from that of other chromosomes because of its constant attachment to the nucleolus. Apart from its being a nucleolar organizer, its long arm terminates in euchromatic fashion. Termination segment of euchromatin pattern is longer than the euchromatic terminal segment of long arm of chromosome No. 6 and thus long arms of both chromosomes can be distinguished from each other.

The centromeres were not easily discernible. However, these are spotted out as small gaps flanked on either side by the heterochromatic regions. Venkateswarlu and Pantulu (1968), while studying the morphology of the pachytene chromosomes in pearl millet, also reported that in all the seven chromosomes the centromeres are flanked by deep stained regions. In this species the nucleolus is conspicuous at pachytene and the nucleolus organizing region is almost terminal. In the present studies, chromosome No. 1 (the longest in the complement) has been found to have submedian centromere and this observation is in agreement with that of Venkateswarlu and Pantulu (1968). But Pantulu (1958) classified it as a median chromosome. Chromosomes 2 and 3, which are next in order of decreasing length, have median centromeres. Similar observations have been made by Venkateswarlu and Pantulu (1968), Chromosomes 4, 5 and 6 are submedian whereas Pantulu (1958) puts the 6th chromosome in subterminal group. The seventh chromosome, which in the current studies has been observed to be subterminal was also classified as such by Pantulu (1958), and Venkateswarlu and Pantulu (1968).

Krishnaswamy and Raman (1951) observed three median and four submedian chromosomes in the somatic complement of *P. typhoides*. Gill and Gupta (1966) reported three median, three sub-median and one subterminal chromosome in somatic cells of *P. typhoides*. They further observed that a pair of satellited chromosomes is one of the longest. Kumar *et al.* (1965) had also reported similar observations. Al-Fakhry *et al.* (1964) put the satellited chromosome at the 4th place in order of length. All these observations on somatic chromosomes differ from the current studies where the shortest chromosome of the complement has been found

to be a nucleolous organizer. Venkateswarlu and Pantulu (1968) also found the nucleolus organizer chromosome to be the shortest. In a separate study on the somatic chromosomes of BIL-4 in this laboratory (Virmani and Gill) shortest chromosome was observed to be nucleolus organizer. The differences in arm ratios reported in various studies could be due to the use of different varieties in such studies. In the present studies, the point of attachment of the nucleolus with the chromosome was observed to be heavily stained and like a telomere dot. Similar findings have been reported by Bus and Cleveland (1968) in *Medicago sativa*.

Summary

At pachytene all the seven bivalents could be followed in well spread cells. The chromosomes length varied from 24.76 micron for the shortest to 48.41 microns for the longest. Centromeres are not easily discernible, these are spotted out as small gaps flanked on either side by deep stained regions. The nucleolus organizing chromosome is the shortest and the nucleolus is conspicuous at pachytene. The nucleolus organizing region is almost terminal.

Literature

- AL-Fakhry, A. K., Sarvellan, F. and Grogan, C. O. 1964. Somatic chromosomes of babala. *J. Hered.* **55**: 57-60.
- Bus, G. R. and Cleveland, R. W. 1968. Pachytene chromosomes of diploid *Medicago sativa*. *Crop Sci.* **8**: 744-747.
- Gill, B. S. and Gupta, A. K. 1966. Study of karyomorphology in *Pennisetum typhoides* S. and H. *J. Res. (PAU)* **3**: 118-21.
- Krishnaswamy, N. and Raman, V. S. 1951. Cytogenetical studies in the interspecific hybride of *Pennisetum typhoides* × *Pennisetum purpureum*. *Proc. 1st. Scient. Workers Conference. Deptt. Agri. Madras* 43-71.
- Kumar, L. S. S., Sharma Rao, K. K. and Thombre, M. V. 1965. Interspecific and intergeneric hybridization in breeding of crop plants. *Ind. J. Genet.* **26A** (Suppl.): 114-120.
- McClintock, B. 1929. Chromosomes morphology of *Zea mays*. *Science* **69**: 629-630.
- Pantulu, J. V. 1958. A case of chromosomal interchange in pearl millet. *Curr. Sci.* **27**: 497-498.
- Venkateswarlu, J. V. and Pantulu, J. V. 1968. Morphology of pachytene chromosomes in pearl millet. *J. Hered.* **59**: 69-79.
- Virmani, S. S. and Gill, B. S. 1972. Somatic chromosome of *Pennisetum typhoides* (Burm.) S. and H. *Cytologia* **38**: 257-260.
-