A detailed pachytene karyotype analysis was carried out in several accessions of *Setaria italica* (L.) Beauv. The pachytene chromosomes of different accessions showed well marked variations in the length of the long arms, short arms and of the total chromosomes. A significant variability was noticed in the amount and distribution pattern of chromomeres.

**Key words**: Chromomere, Idiogram, Karyotype, Pachytene.

Millets have socio-economic, food-feed, health and environmental impact on the resources of poor people of the world. These under researched crops are nutritious, valued culturally, adapted to harsh environments, and diverse in terms of their genetic, agro climatic and economic niches. Karyotypes are dynamic structures evolving through numerical and structural changes. For several decades, karyotype diversity has been a crux of plant evolution studies for two main reasons (Levin, 2002). First, chromosome rearrangements often result in partial or complete barriers to inter-specific gene flow and second, karyotypes may provide insights into the relationship between species. Usefulness of the pachytene stage of meiosis for studying detailed morphology of the chromosome was first demonstrated by McClintock (1931) and was subsequently emphasized by larger number of workers. The present paper deals with detailed analysis of the pachytene karyotype in nine accessions belonging to the cultivated species *Setaria italica*.

**MATERIALS AND METHODS**

Nine accessions, procured from National Bureau of Plant genetic Resources (NBPRGR), of *S. italica* were worked out (Table 1). Young floral buds of different sizes were collected and fixed in Carnoy’s fluid (6:3:1::absolute ethanol:chloroform:glacial acetic acid) for at least 48 hours and then stored in 70% ethanol in refrigerator. Anthers were smeared and squashed one at a time in 1.5% acetocarmine. The pachytene chromosomes were analysed from the photomicrographs taken by computerized Nikon Image Capturing system.

The parameters analysed included (a) Total length of the chromosome of a complement (TLCC), (b) Length of long and short arms and of the whole chromosome, (c) Arm’s ratio (AR), (d) Total length of all short arms (TLSA), (e) Total length of all long arms (TLLA), (f) Centromeric index (ci), (g) Gradient index (GI), (h) Symmetry index (SI), (i) Total chromatin length (TCL %), (j) Relative length of the chromosome of a complement in relation to the longest chromosome of the cell (RL(A)) and all the cells studied (RL(B)), (k) Percent chromomere per arm (%Chrom.), and (l) Percent chromomere per chromosome (CPC%).

Arm’s ratio = \(
\frac{\text{Length of long arm of a chromosome}}{\text{Length of short arm of a chromosome}}
\)
idiograms showing the pattern of distribution and the amount of the chromomeres present in individual pachytene chromosomes of different accessions are presented in Figures 10-18. In most of the chromosomes of a compliment, the portions around the centromeres in both the arms were positively heteropycnotic, evidencing the aggregation of chromomeres around the centromeres. However, some chromosomes exhibited great inconsistency in the amount of chromomeres and CPC% were worked out using the below and also in the pattern of chromomere distribution. All the compliments possessed ‘m’ or ‘sm’ type of chromosomes as per Levan et al. (1964). As per Stebbins (1958), 5

The pachytene chromosomes of the complement were arranged, on the basis of the

d and CPC% were worked out using the below given formulae.

The pachytene chromosomes of the complement were arranged, on the basis of the

Table 2: Data related to pachytene karyotype of Setaria italica accessions.

<table>
<thead>
<tr>
<th>Acc.</th>
<th>TLSA</th>
<th>TLLA</th>
<th>TLCC</th>
<th>GI</th>
<th>SI</th>
<th>Karyotype Formulae</th>
<th>KC</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>692.92</td>
<td>291.46</td>
<td>401.46</td>
<td>46.06</td>
<td>72.60</td>
<td>2B(m)+2B(sm)+10C(m)+2C(sm)+2D(m)</td>
<td>1B</td>
</tr>
<tr>
<td>S-2</td>
<td>789.08</td>
<td>320.71</td>
<td>468.37</td>
<td>36.02</td>
<td>68.47</td>
<td>2A(m)+2A(sm)+2B(m)+6C(m)+2C(sm)+2D(sm)</td>
<td>1B</td>
</tr>
<tr>
<td>S-3</td>
<td>690.41</td>
<td>280.51</td>
<td>409.90</td>
<td>34.98</td>
<td>68.43</td>
<td>4B(m)+4C(m)+8C(sm)+2D(sm)</td>
<td>1B</td>
</tr>
<tr>
<td>S-4</td>
<td>616.89</td>
<td>255.68</td>
<td>361.21</td>
<td>32.74</td>
<td>70.78</td>
<td>2B(m)+10C(m)+6D(m)</td>
<td>1B</td>
</tr>
<tr>
<td>S-5</td>
<td>701.80</td>
<td>304.06</td>
<td>397.74</td>
<td>30.93</td>
<td>76.45</td>
<td>6B(m)+8C(m)+2D(m)+2D(sm)</td>
<td>1B</td>
</tr>
<tr>
<td>S-6</td>
<td>635.14</td>
<td>262.75</td>
<td>372.40</td>
<td>37.89</td>
<td>70.56</td>
<td>4B(sm)+8C(m)+6D(m)</td>
<td>2B</td>
</tr>
<tr>
<td>S-7</td>
<td>659.04</td>
<td>274.56</td>
<td>384.49</td>
<td>47.32</td>
<td>71.41</td>
<td>2B(m)+8C(sm)+2C(sm)+4D(m)+2D(sm)</td>
<td>2B</td>
</tr>
<tr>
<td>S-8</td>
<td>689.41</td>
<td>282.56</td>
<td>406.85</td>
<td>55.39</td>
<td>69.45</td>
<td>4B(m)+8C(sm)+2C(sm)+2D(m)+2D(sm)</td>
<td>1A</td>
</tr>
<tr>
<td>S-9</td>
<td>612.22</td>
<td>247.71</td>
<td>364.51</td>
<td>62.11</td>
<td>67.96</td>
<td>10C(m)+4C(sm)+4D(m)</td>
<td>1A</td>
</tr>
</tbody>
</table>

TLSA=Total length of short arms (μm); TLLA=Total length of long arms (μm); TLCC=Total length of chromosome complement (μm); GI=Gradient index; SI=Symmetry index; KC=Karyotype Characterization (Stebbins, 1958).

total length, into four types, A-D (A>60.00 μm, B=45.00-60.00 μm, C=30.00-45.00 μm, D<30.00 μm). These chromosomes were further assorted into different types M=Median, m=metacentric, sm=submetacentric, st=subtelocentric, t=telocentric on the basis of the arm’s ratio as per Levan et al. (1964). The pachytene karyotypes were also classified into various categories as per Stebbins (1958).

**OBSERVATIONS**

Data pertaining to various parameters related to pachytene karyotype are tabularized in Table 2. The photomicrographs of the pachytene chromosomes are presented in Figures 1-9. The accessions showed 1B type, 2 accessions showed 2B type and 2 accessions showed 1A type of karyotypes.

**DISCUSSION**

From a cytological standpoint the millets have not received much attention. Cytological studies in most of the genera are confined to the determination of chromosome numbers only. Various studies regarding this aspect have been conducted by several workers (Church 1929, Morinaga 1929, Rau 1929, Nakajima 1930, Avdulov 1931, Hunter 1934, Krishnaswamy and Ayyanger 1935, 1941, Kishimoto 1938, Krishnaswamy 1939, 1940, Burton 1942,
Plate-1 (Figures 1-9): Pachytene Chromosomes of nine accessions of *Setaria italic*
Figures 10-18: Pachytene karyotype of a accession of *Setaria italica*
Chandola 1959). During the present undertaking, the details of pachytene karyotypes were analyzed using the parameters as per Srivastava and Purnima (1990) and Srivastava and Kalara (1996). Variability within the individual chromosomes with respect to the size, shape and position of centromere, as well as, the amount and pattern of distribution of chromomeres was found to be well marked. The chromomeres (also called as heterochromatin knobs) are considered as an important landmark of a pachytene chromosome (Chen et al. 2000). As per McClintock et al. (1981) the size, number and chromosomal distribution of chromomeres vary between strains but are constant within strains. But, contrasting observations were made during the present investigation. A marked variation in the architecture of pachytene karyotype was observed between different accessions of S. italica indicating intra-specific karyotype polymorphism.

REFERENCES
Church GL 1929 Meiotic phenomena in certain Gramineae II. Paniaceae and Andropoganeae. Bot Gaz 88 63-84.
Krishnaswamy N 1939 Cytological studies in a haploid plant of Triticum vulgare. Hereditas 25 77-86.
Krishnaswamy N 1940 Untersuchungen zur Cytologie und Systematik de Gramineen. Beihefte zum Botanischen Centralblatt 60 1-56.
Morinaga T 1929 Interspecific hybridisation in Brassica. II. The cytology of F1 hybrids B. cerna and various other species with 10 chromosomes. Jap J Bot 4 277-289.
Nakajima G 1930 On the chromosome number in some agricultural plants. Jap J Gen 5 172-176.
Rau NS 1929 Further contributions to the cytology of some crop plants of South India. *J Ind bot Soc* 8 201-206.

