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Abnormal Meiosis in hexaploid *Setaria verticillata*

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With 6 Figures

Introduction

Setaria BEAUV. is an important genus of the tribe *Paniceae* of the family *Gramineae*. Seventeen species from the genus have been listed by BOR 1960 from Burma, Ceylon, India and Pakistan. However, no detailed biosystematic work in the genus has ever been undertaken. The genus was, therefore, selected by the authors for intensive study. Collections have already been made from Hastinapur, a place having luxuriant vegetation and located 36.4 kilometers north-east of Meerut. During these collections plants belonging to *Setaria verticillata* were collected several times and the cytological study revealed that only hexaploid race was represented. The diploid, tetraploid and hexaploid chromosome counts were already known in the species (AVDULOV 1931, 2n = 36; DE WET 1954, 1956, 2n = 18; and MEHRA & al. 1968, 2n = 18, 36, 54). In these earlier reports, meiosis was reported to be normal at all the three ploidy levels. In the present study, material from number of plants collected at different times, was studied. Meiosis was always found to be abnormal. The details of abnormal meiosis in this taxon are being reported in this paper.

Material and methods

The spikes were fixed in Carnoy's fluid (Absolute alcohol: chloroform: acetic acid, 6 : 3 : 1) in the field. The fixed material was brought to the laboratory and studied within a week. The anthers were squashed in 1%

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aceto-carmine. The camera lucida drawings were made from the temporary preparations. The slides were retained in a solution of 45% acetic acid: glycerine (10 : 1) a drop of which was allowed to flow under the cover glass.

Results

The meiosis was fairly irregular throughout. The meiotic irregularities were mainly to two kinds. Due to partial asynapsis, univalents at metaphase I, laggards at anaphase I and anaphase II and micronuclei at the quartet stage were observed. The second kind of abnormalities included multipolar spindles and other spindle abnormalities. Due to these irregularities, it was difficult to make a detailed analysis at metaphase I. However, it was possible to count 27 bivalents in certain cells (Fig. 1). Although no multivalents could be observed, univalents were common. An analysis of univalents at metaphase I is presented in Table 1. The frequency distribution does not include those cells where the analysis was difficult or where spindle abnormalities were rather pronounced.

Table 1

Frequency distribution of univalents at metaphase I in hexaploid *Setaria verticillata*

No. of PMCS studied	Frequencies of PMCS with univalents							Mean no. of univalents per PMC
	0	1	2	3	4	5	6	
54	43 79.3%	2 5.6%	1 1.8%	1 1.8%	3 5.4%	1 1.8%	3 5.4%	0.79

Table 2

Frequency distribution of laggards at anaphase I in hexaploid *Setaria verticillata*

No. of PMCS studied	Frequency of PMCS with laggards					Mean no. of laggards per PMC
	0	1	2	3	4	
121	97 80.1%	5 4.1%	13 10.7%	2 1.7%	4 3.3%	0.43

Table 3

Frequency distribution of laggards at anaphase II in hexaploid *Setaria verticillata*

No. of cells studied	Frequency of dyad cells with laggards						Mean no. of laggards per dyad cell
	0	1	2	3	4	5	
32	18 55.99%	3 9.4%	4 12.5%	3 9.4%	1 3.4%	3 9.4%	1.2

Table 4

Frequency distribution of micronuclei at the quartet stage in hexaploid *Setaria verticillata*

No. of cells studied	Frequency of cells with micronuclei						Mean no. of micronuclei/cell
	0	1	2	3	4	5	
27	16 58.2%	4 14.8%	1 3.7%	3 11.1%	1 3.7%	2 7.4%	1.09

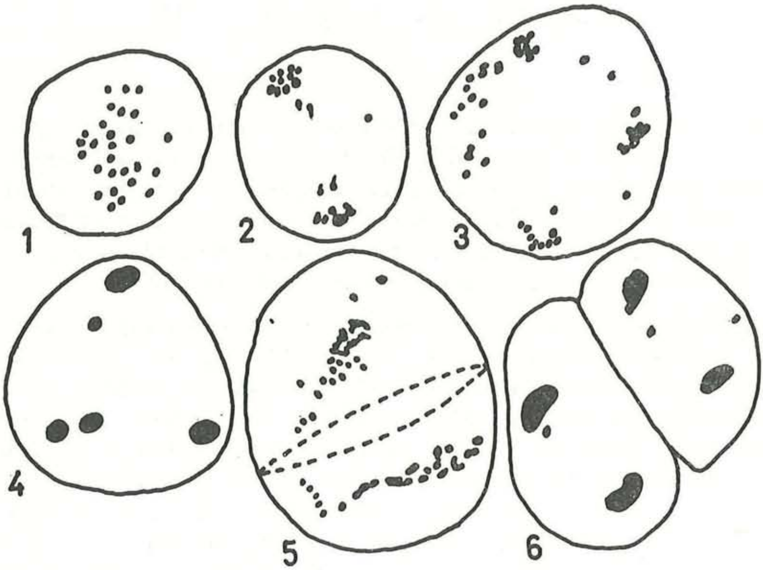
At anaphase I, laggards were observed (Fig. 2). The frequency distribution of laggards is presented in Table 2. The laggards were common at anaphase II also (Fig. 6). The frequency of laggards was higher at anaphase II (Table 3). Similarly the frequency of micronuclei at quartet stage is presented in Table 4. Like Table 1, other tables also do not include those cells where due to spindle abnormalities, no scoring was possible.

In certain cells the chromosomes were seen assembled at three poles with scattered chromosomes in between (Fig. 3). Due to such spindle abnormalities, pollen mother cells with multinucleate condition were also observed (Fig. 4). Whether such abnormalities were followed by cytokinesis is not known. However, the first division in the normal cases was followed by cytokinesis and the abnormalities were observed in the dyad cells also. In the dyad cells sometimes the chromosomes were found arranged in a linear fashion parallel to the plane of division (Fig. 5). Besides multinucleate condition, scattered chromosomes were also observed showing that there was spindle breakdown in the second division also. Pollen fertility unfortunately could not be worked out.

Discussion

Abnormal meiosis has been reported in a large number of grasses. Earlier a case of complete breakdown of meiosis in a clone from *Dichanthium-Bothriochloa* complex was reported from this laboratory (Gupta & Srivastava 1970). Therefore, a variety of abnormalities are known in this group of plants. While the presence of multivalents in a polyploid could be explained to be due to autosyndesis, the presence of univalents would be due to partial asyndesis. Such abnormalities are more frequent in apomictic grasses. In the genus *Setaria*, the apomictic species known so far are *Setaria villosissima* and *S. leucophila* (Brown 1958). *S. verticillata* has never been reported to be apomictic. However, due to the abnormalities reported here, the possibility of this species being apomictic can not be ruled out.

In the present material, there was evidence of partial asyndesis. The data presented in Table 1 and Table 2 indicated that the mean number of univalents per cell (0.79) at metaphase I was more than the mean number of laggards per cell at anaphase I (0.43). This suggested that univalents could either lag or get included in the nuclei. However, increased frequency of laggards at anaphase II (1.2) could be due to lagging or misdivision of



Figs. 1—6, Meiosis in hexaploid *Setaria verticillata*. Fig. 1, Prometaphase, showing 27 bivalents; Fig. 2, anaphase I showing laggards; Fig. 3, anaphase I, showing three poles and scattered chromosomes; Fig. 4, a multinucleate microsporocyte; Fig. 5, a dyad showing chromosomes arranged parallel to the plane of division; Fig. 6, anaphase II showing laggards.

such univalents which were included in the first division. There is no appreciable difference in the frequency of laggards at anaphase II and the frequency of micronuclei at the quartet stage. Therefore, only very few laggards, if at all, were included in the nuclei at telophase II.

The presence of multinucleate microsporocytes in the present material can be compared with the earlier similar reports in *Bromus* (Walters 1958, 1960). In our laboratory multinucleate microsporocytes were also observed in *Paspalum paspaloides*, an apomict (Gupta & Srivastava, 1972). Walters 1960 explained the presence of multinucleate condition to be due to subdivision of the pre-existing nuclei. However, they could also result due to multipolar spindle or spindle breakdown. In the latter case, several nuclei could result due to aggregates of separate chromosomes.

Since several plants collected at different times showed similar abnormalities, the meiosis described in *Setaria verticillata* should be inherent in the genetic constitution of the material. It is also possible that this genetic constitution is somehow adapted to the ecological niche which is unique to the area from where the material was collected.

Summary

Several plants of *Setaria verticillata* BEAUV. collected from Hastinapur, a place 36.4 kilometers from Meerut, were cytologically examined. All of them were hexaploid and were consistent in exhibiting the same type of meiotic abnormalities.

The meiotic abnormalities were mainly of two types. The presence of univalents in a low frequency led to the formation of laggards and micronuclei at both the meiotic divisions. Multipolar spindles and perhaps spindle breakdown led to the presence of multinucleate microsporocytes. The data pertaining to these abnormalities have been described and discussed.

Zusammenfassung

Mehrere Pflanzen von *Setaria verticillata* BEAUV. aus dem Gebiet von Hastinapur, 36,4 km von Meerut (Indien) wurden zytologisch untersucht. Alle waren hexaploid und zeigten übereinstimmend die gleichen abnormen Meiosen. Diese entsprechen hauptsächlich zwei Typen. Das Auftreten von Univalenten in geringer Häufigkeit führt zur Ausbildung von Nachzüglern und Kleinkernen in beiden meiotischen Teilungen. Multipolare Spindeln und möglicherweise Spindelzerfall führen zu vielkernigen Mikrosporozyten. Diese Abnormitäten werden beschrieben und näher besprochen.

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