Cytology of Genus *Sporobolus* R. Br. from North India (Punjab Plain)

S. S. Bir, Manju Sahni and C. P. Singh

Department of Botany, Punjabi University, Patiala-147 002, India

Accepted September 5, 1986

The genus *Sporobolus* R. Br. of tribe Sporoboleae in family Graminae consists of 150 species which are tropical and warm temperate in distribution (Airy Shaw 1973). Out of these, only 16 species are recorded from the Indian subcontinent (Bor 1960).

So far, chromosome numbers of 55 species have been recorded and these vary from $2n=12$ to $2n=126$ (see foot note to Table 1). From India, only 8 species have been studied (Mehra *et al.* 1968, Christopher and Abraham 1974, Mehra 1982, Christopher 1985), but taxa from different phytogeographic regions of the country have not been fully investigated so far. Therefore, as a part of our project of cytological studies on North Indian grasses and sedges, the present work was undertaken on the members of *Sporobolus* from Punjab plain from where only 6 species have been recorded (Sharma 1983 and the writers). Except for *S. fertilis* (Steud.) W. D. Clayton which is very rare in Punjab and could not be collected, all others have been presently chromosomally investigated.

Materials and methods

Details of localities from where the materials were collected are available in Table 1. Meiosis in young floral buds was studied following usual acetocarmine technique. Pollen fertility was ascertained by Mark's (1954) method. In order to reveal the existing cytological variability, if any, in each case, intensive analysis was done not only of several individuals but also of several populations.

Observations

Information about chromosome numbers recorded, ploidy level of taxa and the pollen fertility is given in Table 1. All the investigated taxa have normal meiosis except in case of *S. helvolus* and *S. indicus*. Three species, namely, *S. coromandelianus*, *S. helvolus* and *S. indicus* show the presence of 18II at diakinesis and M-I and $18+18$ or $(18+18)+(18+18)$ chromosomes at A-I and A-II (Figs. 1, 2, 3 respectively). For *S. diander* and *S. marginatus*, two cytotypes each with $n=12$ (Fig. 4) and $n=18$ (Fig. 5) for the former and $n=9$ (Fig. 6) and $n=18$ for the latter species are recorded (cf. Table 1).

In *S. helvolus* with $n=18$ (4x) phenomenon of cytomixis has been observed in 38.5% of observed pollen mother cells (PMCs) at different stages of meiosis. Actual passing of chromatin material is seen in 63.4% of the cytomictic cells (Fig. 7). As a result of transmigration of nuclear material PMCs with increased (not countable) and decreased ($n=8, 10, 14, 15, 16$), chromosome numbers have been located (Figs. 8, 9, 10). Due to these abnormalities, pollen fertility is reduced to 85.8%. In *S. indicus* nearly 72.7% of the observed PMCs show the presence of laggards and bridges at A-I which leads to highly decreased pollen viability (20.5%).

The tetraploid and hexaploid cytotypes of *S. diander* can be distinguished easily as the tetraploids are taller (52–57 cm) with bigger leaves (12–17 cm), large sized inflorescence (23–

26 cm) and large sized pollen ($24 \times 20-23 \times 28 \mu\text{m}$) as compared to hexaploid plants which are smaller in size (28–39 cm), possess smaller leaves (4.5–7.5 cm) and inflorescence (10–18 cm). The pollen are nearly of the same size ($24 \times 20-28 \times 24 \mu\text{m}$) as in case of tetraploids. It may be stated that both the cytotypes were growing under similar habitat conditions. However, in *S. marginatus* the tetraploid plants are more robust in appearance (55–60 cm) with bigger leaves (9.5–11.5 cm) and inflorescence (10.5–11 cm), but with small pollen ($24 \times 20-24 \times 24 \mu\text{m}$) as compared to the diploid plants which are 30–32 cm tall, possess smaller (7–10.5 cm) sized leaves and 8.5–10.5 cm long inflorescence and comparatively bigger sized ($24 \times 24-28 \times 28 \mu\text{m}$) pollen. Also pollen fertility is much reduced in tetraploids (30–48%) as compared to the diploids (98%).

Discussion

All the presently studied five species of *Sporobolus* are at polyploid level and are based on $x=6$ (*S. diander*) and $x=9$ (*S. coromandelianus*, *S. helvolus*, *S. indicus* and *S. marginatus*). Three well represented base numbers as $x=9$, 10, 12 have been suggested (cf. Darlington and Wylie 1955, Fedorov 1969, Moore 1973) for the genus. Tateoka (1965) reported $n=6$ in *S. molleri* from Uganda and another base number $x=6$. Later on, Christopher (1985) on the basis of record of $n=6$ for *S. maderapatonous* from South India supported the presence of $x=6$. Now with the recording of $n=12$ ($4x$) and $n=18$ ($6x$) for *S. diander* from North India, the existence of $x=6$ for *Sporobolus* is confirmed. This is a primary number for the genus and the other numbers $x=9$, 10 have evolved through aneuploidy from $x=6$. The existence of $x=12$ is ruled out because the species supporting $n=12$ and considered diploid as based on 12, are now scored as tetraploid as based on $x=6$. Eventually, the genus *Sporobolus* is tribasic with $x=6$, 9 and 10.

On world-wide basis the cumulative cytological data* for 89 investigated taxa show that 83.03% are polyploids and the following species* show intraspecific cytotypes (both eu- and aneuploids): *S. airoides* ($2n=90$, 108, 126), *S. asper* ($2n=54$, 88, 108), *S. berteroomus* ($2n=36$, 44), *S. capensis* ($2n=18$, 36), *S. coromandelianus* ($2n=24$, 36), *S. cryptandrus* ($2n=18$, 36, 38, 72), *S. cubensis* ($2n=72$, 80, 90), *S. diander* ($2n=24$, 36), *S. fertilis* ($2n=24$, 36, 48), *S. festivus* ($2n=18$, 24, 36, 40–45, 48, 54), *S. marginatus* ($2n=18$, 20, 36), *S. piliferus* ($2n=20$, 36), *S. pyramidalis* ($2n=24$, 30, 36), *S. pyramidatus* ($2n=24$, 30, 36, 54), *S. stapfionus* ($2n=24$, 36), *S. tenuissimus* ($2n=12$, 40), *S. tremulus* ($2n=20$, 48), *S. virginicus* ($2n=18$, 20, 23–30, 30), *S. wallichii* ($2n=24$, 40).

The cause for aneuploid numbers could be sought in the presence of cytotoxic PMCs as recorded by us in *S. helvolus* for the first time in the genus *Sporobolus* as well as irregular divisions during sporogenesis as noticed in *S. indicus*. This ultimately leads to genetically imbalanced pollen and the resultant different biotypes which are easily perpetuated in nature through vegetative propagation so common in grasses.

It is very likely that cytotoxicity is prevalent in other species too, but this has not been noticed so far. The existence of polyploid cytotypes at intraspecific level, raises an important question as to the taxonomy of the concerned species. The taxonomic reflections of cytological differences well supported by morphological differences as brought out presently from *S. diander*

Figs. 1–10. 1, *Sporobolus coromandelianus* PMC at diakinesis showing 18II. 2, *S. helvolus* M-I with 18II. 3, *S. indicus* diakinesis with 18II. 4, *S. diander* M-I showing 12II. 5, *S. diander* diakinesis showing 18II. 6, *S. marginatus* A-I with 9:9 distribution of chromosomes. 7–10: *S. helvolus*. 7, PMCs showing cytotoxicity. 8, 9, 10, cells after cytotoxicity with aneuploid numbers (8, 6II+2I.9, 12II.10, 16II)

* Based on information given in references mentioned in foot note (*) to Table 1 and present observations.

Table 1. Chromosomal data for species of genus *Sporobolus* from Punjab plains

S. no.	Name of taxon	Locality	Chromosome number	Ploidy level	Pollen fertility	PUN accession number/s	Previous reports from India*
1	<i>S. coromandelianus</i> (Retz.) Kunth	Univ. Campus Patiala 250 m	n=18	Tetraploid	97.0	28196	2n=24; Christopher and Abraham 1974 2n=36; Narayan and Muniyamma 1972, Bir and Sahni 1983
2	<i>S. diander</i> (Retz.) P. Beauv. Population 1	Univ. Campus Patiala	n=12	Tetraploid	100.0	31300	2n=24; Gupta and Yashvir 1971, Christopher and Abraham 1974, Mehra 1982
	Population 2	Univ. Campus Patiala	n=18	Hexaploid	94.2	30082-84	2n=54; Mehra <i>et al.</i> 1968
	Population 3	V. Mahorana Sangrur 240 m	n=18	Hexaploid	100.0	28973	2n=24, 36; Sahni and Bir 1985
3	<i>S. helvolus</i> (Trin.) Th. Dur et Schinz	Ferozepur Head work, 206 m	n=18	Tetraploid	85.8	32161	2n=36; Sahni and Bir 1985
4	<i>S. indicus</i> (Linn.) R. Br.	Rajpura Road Patiala	n=18	Tetraploid	20.5	31274	2n=18; Mehra <i>et al.</i> 1968 2n=36; Sahni and Bir 1985 2n=48; Christopher and Abranam 1974
5	<i>S. marginatus</i> Hochst Population 1	Sadhu Bela Patiala	n=9	Diploid	98.0	28201	2n=18; Bir and Sahni 1984 2n=36; Mehra <i>et al.</i> 1968
	Population 2	NIS Patiala	n=18	Tetraploid	30.3	31278	
	Population 3	V. Mahorana Sangrur	n=18	Tetraploid	48.0	28997	

* Previous reports compiled from Darlington and Wylie (1955), Löve and Löve (1961, '74, '75), Fedorov (1969), Index to plant chromosome number (1956 onwards) and IOPB chromosome number reports as published in Taxon 1965 onwards and SOCGI chromosome number reports I, II, III (1983, '84, '85). Irrespective of the fact whether n or 2n chromosome numbers are compiled by previous workers, we have invariably mentioned the '2n' numbers. References to workers mentioned under column 8 on previous reports are excluded at the end. Reader is referred to the above mentioned works.

and *S. marginatus*, has to wait till comparisons with the type materials are made. In any case, there is an urgent need for the taxonomic revision of the genus *Sporobolus*.

Summary

As a result of chromosomal analysis of various populations of five species of genus *Sporobolus* it has been found that (i) morphologically distinct tetraploid ($n=12$) and hexaploid ($n=18$) cytotypes for *S. diander* and diploid ($n=9$) and tetraploid ($n=18$) cytotypes for *S. marginatus* exist in nature, (ii) cytotoxicity leading to aneuploid numbers characterises *S. helvolus* and (iii) abnormal meiosis results in reduced pollen fertility in *S. indicus*.

All the five species are polyploids. On the basis of cumulative world wide data 83% of the species of genus *Sporobolus* are polyploids and intraspecific cytotypes exist in a large number of species. This calls for taxonomic revision of the genus in the light of cytomorphological evidence.

Acknowledgements

One of us (MS) is thankful to CSIR for financial assistance.

References

- Airy Shaw, H. K. 1973. A Dictionary of Flowering Plants and Ferns. Univ. Press Cambridge (Revised 8th ed. of the late J. C. Willis).
- Bir, S. S. and Sahni, M. 1983. In: SOCGI Chromosome Number Reports I. J. Cytol. Genet. **18**: 56-63.
- and — 1984. In: SOCGI Chromosome Number Reports II. J. Cytol. Genet. **19**: 111-117.
- Bor, N. L. 1960. Grasses of Burma, Ceylon, India and Pakistan. Pergamon Press.
- Christopher, J. 1985. Basic number six in *Sporobolus* from South India. Curr. Sci. **54**(17): 880.
- and Abraham, A. 1974. Studies on the cytology and phylogeny of South Indian Grasses II. Sub-family Eragrostoideae. Cytologia **36**: 561-571.
- Darlington, C. D. and Wylie, A. P. 1955. Chromosome Atlas of Flowering Plants. London, George Allen Unwin Ltd.
- Fedorov, An. A. (ed.) 1969. Chromosome Number of Flowering Plants. Kurnikov Botanical Institute USSR, 926 pp.
- Gupta, P. K. and Yashvir, 1971. In: IOPB Chromosome Number Reports XX. Taxon **18**: 609-614.
- Löve, A. and Löve, D. 1961. Chromosome Number of Central and North Western European Plant Species. Opera Botanica Almqvist & Wiksell Stockholm.
- and — 1974. Cytotaxonomical Atlas of the Slovenian Flora. J. Cramer F1 3301 Lehre.
- and — 1975. Cytotaxonomical Atlas of the Arctic Flora. J. Cramer F1 3301 Lehre.
- Mark, G. E. 1954. An acetocarmine glycerol jelly for use in pollen fertility counts. St. Technology **29**: 277.
- Mehra, P. N. 1982. Cytology of East Indian Grasses. New Delhi.
- , Khosla, P. K., Kohli, B. L. and Koonar, J. S. 1968. Cytological studies in the North Indian Grasses. Res. Bull. Panjab Univ. **19**: 157-230.
- Moore, R. J. 1973. Index to Plant Chromosome Numbers 1967-1971. Edited by Moore, R. J. Netherlands.
- Narayan, K. N. and Muniyamma, M. 1972. In: IOPB Chromosome number Reports XXXVIII. Taxon **21**: 679-684.
- Sahni, M. and Bir, S. S. 1985. In: SOCGI Chromosome Number Reports III. J. Cytol. Genet. **20**: 204-207.
- Sharma, M. L. 1983. Grasses of Punjab. Part II. Indian Forester **169**(6): 495-508.
- Tateoka, T. 1965. Chromosome numbers of some East African grasses. Amer. J. Bot. **52**(8): 864-869.
-