Cytogenetical Studies of Three Interspecific Hybrids Between *Pennisetum typhoides* Stapf and Hubb. and *P. purpureum* Schumach

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Introduction

Pennisetum typhoides Stapf and Hubb., commonly known as 'Bajra' is widely grown in India for grain and fodder. Napier or elephant grass, *P. purpureum* Schumach considered to be a high yielding grass was introduced in India during the first or second decade of the present century. The Napier grass is very hardy and resistant to diseases like rust. It is, however, a coarse fodder with low feeding value and inferior palatability as compared to the cultivated 'Bajra'. The grass has a high water requirement and grows luxuriantly only under irrigated conditions and when allowed to grow uncut it becomes fibrous and there is marked reduction in quality. In order to combine good characteristics of the two species, interspecific crosses were attempted by Krishnaswami and Raman (1949), Khan (1960), Patil and Joshi (1962) and Oke (1963). The hybrids were superior over the two parents in agronomic and quality characters. The present investigations aimed to study the meiotic behaviour of three hybrids *P. purpureum* × *P. typhoides*.

Materials and methods

The studies were conducted on the following three Napier—Bajra crosses :

- 1) Pusa Giant Napier (PGN) from I.A.R.I. New Delhi, India.
- 2) Elephant King Grass (EB-4) from College of Agriculture, Poona, India.
- and 3) Pakistan Hybrid (PH) from Agricultural Research Institute, Layallpur, Pakistan.

The parental species *P. typhoides* and *P. purpureum* were also grown along with for comparative studies.

Young earheads of appropriate sizes were collected between 7.15 A.M. and 10.30 A.M. and fixed for 24 hours in fresh Clarks' fixative (ethyl alcohol 3 parts: glacial acetic acid 1 part: ferric chloride traces). The ears were then transferred to 70 per cent ethyl alcohol and kept in refrigerator. Smears were made in 0.75 per cent aceto carmine. The quantitative data relating to chromosome associations and separations were recorded at diakinesis, meta-

phase I, anaphase I, telophase I and metaphase II.

Stainability of pollen with iron acetocarmine was taken as the index of pollen fertility. The stained and plump pollen grains that were filled with cytoplasm were considered as normal and others as aborted.

Results

Meiosis in the parents: Seven bivalents were invariably counted at diakinesis and metaphase I of *P. typhoides*. Meiosis was normal and no irregularity like asynapsis, desynapsis, multivalents, nondisjunctions, etc., was observed at any stage of meiosis. The chromosomal counts of *P. purpureum* revealed that this species is an euploid with $n=14$. Meiosis was normal and there was regular behaviour of the chromosomes. The fourteen bivalents separated normally at anaphase I and 14 chromosomes were invariably counted at metaphase II.

Table 1. Chromosome configuration at diakinesis or metaphase I

Hybrid	Chromosome number	No. of PMCs	Frequency of cells with								
			1 III +7 II +4 I	1 III +6 II +6 I	1 III +5 II +8 I	9 II +3 I	8 II +5 I	7 II +7 I	6 II +9 I	5 II +11 I	4 II +13 I
PGN	21	65	1	—	1	2	18	33	9	—	1
EB-4	21	92	—	4	—	1	14	57	10	5	1
PH	21	68	3	9	6	—	7	30	9	3	1

Table 2. Frequency of various associations at diakinesis or metaphase I

Hybrid	No. of PMCs	Configuration					
		III		II		I	
		Range	Mean	Range	Mean	Range	Mean
PGN	65	0-1	0.031	4-9	7.12	3-13	6.60
EB-4	92	0-1	0.043	4-9	6.88	3-13	7.10
PH	68	0-1	0.264	4-8	6.51	4-13	7.14

Meiosis in the P. typhoides × *P. purpureum* hybrid: The meiosis in the hybrid *P. typhoides* × *P. purpureum* was very irregular. The data pertaining to the chromosomal configurations at diakinesis and metaphase I are presented in Table 1. Various configurations ranging from 1 III+7 II+4 I to 4 II+13 I were observed in the hybrids (Figs. 2-6). The modal configuration in all the hybrids studied was 7 II+7 I. Its frequency was 50.77 per cent, 61.96 per cent and 44.12 per cent in the hybrids PGN, EB-4 and PH respectively. The data pertaining to the frequency of trivalents, bivalents and univalents are presented in Table 2. The trivalents were more frequent in the hybrid PH than the other two hybrids. Their frequency in the hybrid PH, PGN and

Figs. 1-9. 1, diakinesis in *P. typhoides* showing 7 II. 2, diakinesis in EB-4 showing 7 II + 7 I. 3, diakinesis in EB-4 showing 8 II + 5 I. 4, diakinesis in PGN showing 1 III + 5 II + 8 I. 5, diakinesis in PH showing 1 III + 5 II + 8 I. 6, metaphase I in PGN showing scattered univalents. 7, telophase I in PH showing chromosomal bridges. 8, telophase I in PGN showing 5 laggards. 9, telophase I in EB-4 showing 5 laggards.

EB-4 was 0.264, 0.031 and 0.043 per cell respectively. Frequently cells with more than and less than 7 bivalents were observed. In all the cases as low as 4 bivalents were observed and in the hybrids PGN and EB-4 configurations having 9 bivalents were seen.

The behaviour of the trivalents and univalents, as expected, was very irregular at anaphase I. Due to irregular behaviour of univalents 5 to 11 chromosomes were countable at the two poles (Table 3). The mean chromo-

Table 3. Chromosome separation at anaphase I

Hybrid	No. of PMCs	Frequency of cells with							Mean chromosome at poles
		11-	10-	9-	8-	7-	6-	5-chromosome at poles	
PGN	24	1	5	6	14	19	3	—	7.875
EB-4	22	3	6	7	11	13	3	1	8.136
PH	23	1	2	4	18	16	5	1	7.783

Table 4. Analysis of laggards at anaphase I

Hybrid	No. of PMCs	Frequency of cells with							Mean laggards per cell
		8-	7-	6-	5-	4-	3-	2-laggards	
PGN	24	1	5	7	2	5	3	1	5.250
EB-4	22	1	3	4	2	6	4	2	4.682
PH	23	1	8	5	4	4	2	—	5.913

Table 5. Analysis of laggards at telophase I

Hybrid	No. of PMCs	Percentage of PMCs with							Mean laggards per cell
		6-	5-	4-	3-	2-	1-	0-laggards	
PGN	35	—	2	6	6	9	8	4	2.229
EB-4	32	1	3	2	8	8	7	3	2.375
PH	74	4	8	4	13	18	11	16	2.243

some number at the poles in the various hybrids ranged from 7.783 to 8.136. The univalents mostly lagged at the centre. The data pertaining to laggards at anaphase I are presented in Table 4. Two to 8 laggards were observed in the hybrids. The average number of laggards per cell in the three hybrids under study ranged from 4.682 to 5.913. The frequency of laggards being highest for PH.

Upto 6 laggards were observed at telophase I (Table 5) (Fig. 7-8). The frequency of laggards at telophase I was much less than that at the anaphase I. This shows that some of the univalents were constituted in one or the other pole at telophase. The conclusion drawn was further confirmed at

metaphase II when the number of chromosomes per cell (Table 6) was more than that counted at anaphase I. The differences between hybrids for number of chromosomes per cell at metaphase II were very little. Some of the PMCs showed chromosomal bridge at anaphase I and anaphase II (Fig. 7).

Table 6. Chromosomal analysis at metaphase II

Hybrid	No. of PMCs	Frequency of cells with							Mean chromosomes per cells
		7-	8-	9-	10-	11-	12-	13-chromosomes	
PGN	55	—	5	11	13	15	9	2	10.327
EB-4	54	2	4	15	12	11	7	3	10.037
PH	43	—	6	9	7	6	8	7	10.512

Table 7. Pollen fertility of the parents and the hybrids

Species/hybrids	Fertile pollen	Sterile pollen	Total no. of pollen studied	Percentage pollen fertility
<i>P. typhoides</i>	483	67	550	87.82
<i>P. purpureum</i>	198	122	320	61.87
PGN	4	121	125	3.20
EB-4	16	164	180	8.88
PH	17	383	400	4.25

Pollen fertility: The data concerning percentage pollen fertility in the species *P. typhoides* and *P. purpureum* and the three hybrids involving these species are given in Table 7. The hybrids were highly sterile and had 3.20 per cent to 8.88 per cent fertile pollen. The pollen fertility of *P. typhoides* was higher than that of *P. purpureum*.

Discussion

Concurrent with the findings of *Avuldox* (1931), Burton (1944), Krishnaswamy and Raman (1949), the chromosome numbers $n=7$ for *P. typhoides* and $n=14$ for *P. purpureum* were found in the present investigation. Rau (1929), and Rangasway (1935) have also reported the same number for *P. typhoides*. Meiosis in both the species was regular and pollen fertility was very high.

Meiosis in the three hybrids studied was highly abnormal. Univalents and trivalents were frequently observed. These later behaved irregularly and lagged at the centre. Occasionally these moved to one or the other pole and resulted in irregular distribution of chromosomes. Most of the metaphase II cells observed had unbalanced number of chromosomes. As a result of irregular constitution of chromosomes most of the pollen produced by the hybrid was sterile.

The modal configuration of chromosomes observed at diakinesis and metaphase I was 7II+7I. This shows that the species *P. purpureum* is an

allotetraploid and carries 7 *P. typhoides* chromosomes. Similarly the modal configuration of 7II+7I has been reported by Krishnaswamy and Raman (1951) in the napier—bajra hybrid.

In several metaphase configurations more than 7 bivalents and occasionally one trivalent were observed. This could be caused by allosyndetic pairing and/or chromosomal rearrangements. The appearance of chromosomal bridges at anaphase I and anaphase II indicate the occurrence of inversions. Similarly other aberrations like translocation might have occurred in these genomes. These translocations could also produce trivalents and additional bivalents.

As a result of irregular meiosis all the three hybrids had highly reduced pollen fertility. Amongst the three hybrids EB-4 had highest pollen fertility (8.88 per cent). The perusal of the metaphase II configuration shows that this hybrid had the maximum number of cells having balanced chromosome.

The three hybrids obtained from different sources had almost similar cytological expression and are believed to have similar chromosomal constitution.

Summary

Meiotic studies of three *P. typhoides* × *P. purpureum* hybrids showed that the species *P. purpureum* (n=14) is an allotetraploid and contains 7 chromosomes of the diploid species *P. typhoides*. There was indication of certain chromosomal aberration in the species *P. purpureum*. The hybrids studied were highly sterile due to meiotic abnormalities. The cytological behaviour of the three hybrids studied was similar.

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