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Investigations on Intra-specific Chromosomal and Morphological variations in *Panicum maximum*

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Introduction: *Panicum maximum* Jacq., the most common of the irrigated grasses was introduced from New Guinea several years back. Strains of this grass possessing specific attributes related to fodder production have been developed in Porto Rico, Brazil, Queensland, Trinidad and Jamaica (Jacobson. 1914; White, 1938; Warmke, 1951 and Motta, 1953). Clones with chromosome numbers as 18, 32. 36, 44 and 48 (2n) have been reported (Moffett and Hurcombe, 1949; Dewet, 1954; Warmke, 1954; Piennar, 1955; Raman *et al* 1959). Taking advantage of the variability noticed in 51 accessions of this species, assembled under the auspices of the scheme on cytogenetics of fodder grasses sponsored by the Indian Council of Agricultural Research and the State Government, detailed studies were undertaken on the morphological and quantitative attributes related to fodder production. Selected clones were also compared in yield tests to isolate superior ones. A comparison of the selfed progenies with those raised from open-pollinated seed was also made. The results of the investigations outlined above are described in this paper.

Material and Methods: Slips of 51 clonal accessions were planted adopting a spacing of 90 cm between rows and 60 cm between plants in a row. Prior to the third harvest, observations were made in respect of different morphological

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and metric characters. For estimating leaf / stem value, 25 tillers in bloom were cut in each clone and the weight of leaf and stem were recorded separately

Twenty-one selected clones were compared in a randomised replicated trial. Eight cuttings were taken. Uniform sized slips were used for planting. A single row consisting of 8 slips formed one replication of which the middle six stools alone were considered for experimental purposes. Observations regarding height of the tallest tiller, number of tillers and weight of green matter produced per clump were recorded at the time of each cutting.

Young panicles were fixed in Carnoy's fluid (9 : 6 : 1 mixture) and stored in 70 per cent alcohol. Meiosis was studied in temporary aceto-carmine smears of P. M. cells.

Results: I. *Morphology:* A study of the clonal accessions (2n : 32) for association of quantitative and morphological attributes related to fodder production indicated significant variations in the habit of growth, mode of tillering, intensity of pigmentation, bloom and hairiness on plant parts, size of stem, leaves and panicles and colour of foliage. Certain accessions were characteristic of particular attributes viz., pubescent glumes (G. 493), purple spikelets (G. 485), coarse and broad leaves (G. 481), open habit of tillering with drooping leaves (G.332) and light green foliage with thin stems and short leaves (G.335). Intensity of bloom and hairiness on plant parts showed no association with the other characters studied. Inter-clonal variation in this species has recently been described by Jauhar and Joshi (1966). A type from Kenya (G.351) was found to be a triploid (2n–48). It was distinct in its tall growth habit, coarse leaves, thick stems and high sensitivity to photoperiod.

Yield of fodder: Twenty one clones were compared in a randomised replicated trial. Highly significant differences were observed in respect of height of plant, number of tillers and yield of green matter (Table 1). Type G. 332 (from West Bengal) characterised by its open type of tillering and long drooping leaves was a poor yielder. Three clones viz., G. 335, G. 403 and G. 409 possessing thin stems, soft and light green foliage were also found to be poor yielders. The clones G. 158 (local) recorded the maximum yield closely followed by clones from Courtallam (G. 290) and Hosur (G. 297). The accessions which gave high yield of fodder possessed green foliage, thick stems, broad and long leaves and were tall and highly tillering. Those possessing dark-green, light-green or blue-green foliage gave poor yields.

In height of plants, the range was from 138 to 176 cm. The triploid recorded the maximum height, closely followed by two diploids. The triploid was medium tillering and the fodder yield was on par with that of high yielding diploid clones. The coarse leaves, hard stems and high sensitivity to photoperiod are traits that render the triploid unsuitable as a quality fodder type

TABLE 1. *Summary of results of yield trial*

S. No.	Clone	Place of collection	Yield of green matter (gm)	Tillers	
				Height (cm)	Number
1.	158	Tamil Nadu	7251	165.3	65.5
2.	290	-do-	7242	158.0	63.4
3.	297	-do-	7041	143.1	60.6
4.	337	I. A. R. I. New Delhi	7019	137.7	57.8
5.	351	Kenya, Africa	6844	176.4	49.1
6.	331	Tamil Nadu	6793	153.2	55.3
7.	245	-do-	6562	167.9	57.7
8.	149	-do-	6406	172.4	51.7
9.	359	-do-	6333	160.5	44.5
10.	336	I. A. R. I. New Delhi	6192	149.1	46.9
11.	334	West Bengal	6134	156.3	51.4
12.	367	Tamil Nadu	5952	152.6	52.9
13.	375	Gujarat	5861	160.7	48.9
14.	363	Tamil Nadu	5618	154.2	60.7
15.	385	Hyderabad	5590	146.0	52.4
16.	333	Tanganiyaka, Africa	5108	161.5	46.9
17.	372	Andhra Pradesh	5074	139.2	56.3
18.	332	West Bengal	4117	160.6	20.4
19.	335	I. A. R. I. New Delhi	3965	148.0	51.7
20.	409	-do-	3735	151.3	63.2
21.	403	Jaipur, M.P.	3411	153.6	50.4

The high yielding clone (G. 158) produced a maximum of 65 tillers, while a minimum of 20 tillers was recorded in another diploid. The triploid had only 49 tillers. The yield of green fodder appears to be influenced more by the number of tillers than by the height of tillers.

The green matter realised in the different cuttings showed that there was a progressive increase in yield from cutting to cutting though the rate of increase between the clones was not similar. The same trend was noticed in respect of the number of tillers also.

Leaf / stem value: The leaf / stem value varied within narrow limits of 0.30 to 0.70. A few clones (G. 468, 486 and 489) were exceptional with a high leaf / stem value (0.80). The triploid gave a value of nearly 1.0. Clones G. 335, 403 and 409 which are low yielders had also low leaf / stem values. The variation in yield offers good scope for selection between the clones, keeping in view the higher limits for leaf / stem value available.

Breeding behaviour: Two diploid clonal accessions, G. 158 and G. 245 were taken up for the study. The seedlings raised from selfed seeds of nine clumps of the former and four of the latter were compared for flowering duration,

number of tillers, height of plant and yield of green matter along with the progeny raised from open pollinated seed. The analysis of data indicated significant differences between the populations for duration of flowering, height of plant and yield of green matter (Table 2). Among the progenies of the two accessions raised from selfed seeds, significant differences existed for all the four characteristics (Table 3).

TABLE 2. *Summary of Results - Open Vs. Self pollinated progenies*

		Open	Self	S.E.D.	C.D. (P=0.05)
Flowering duration (days)	G. 158	56.1	76.2	6.64	13.01
	G. 245	82.3	64.3	4.38	8.58
Height (cm)	G. 158	176.7	150.4	5.83	11.43
	G. 245	160.3	139.4	2.03	4.02
Weight of green fodder (gm)	G. 158	1031.0	802.0	110.30	16.21
	G. 245	Not recorded			

TABLE 3. *Summary of Results - Self pollinated progenies*

Clone	Progeny No.	Flowering duration (days)	Tillers		Weight of green fodder (gm)
			Height (cm)	Number	
G. 158	1	69.6	145.8	49.2	588
	2	67.6	151.3	57.3	332
	3	101.3	184.4	73.6	1015
	4	100.0	159.9	63.7	1398
	5	96.3	164.9	59.8	1203
	6	77.7	157.7	36.7	706
	7	66.7	138.1	36.1	532
	8	68.8	136.8	49.1	632
	9	54.4	130.4	31.9	504
G. 245	1	72.2	137.1	38.1	527
	2	64.5	147.0	46.9	718
	3	65.7	135.6	43.8	517
	4	55.8	136.9	62.9	913

A similar comparison between selfed and open-pollinated progenies was made of the triploid clone for height of plant, number of tillers, length and thickness of internode and peduncle, length and breadth of leaf and panicle. Significant differences were noticed only in respect of number of tillers, length of 4th leaf and boot-leaf and thickness of peduncle. For other characters, the progenies under the two methods of breeding were on par. However, the range of variability was significant in both the cases for all the characters studied.

Aberrant types in selfed progeny: A chromosomal variant with 2n=36 chromosomes was isolated from the selfed progeny of a 2n=32 type. It rarely reached the flowering phase and was very slow in growth. Similarly, a single plant among the selfed progeny of the triploid exhibiting characteristics markedly different from the mother in being late in flowering and stunted in growth was isolated. Warmke (1954) isolated in progeny rows, exceptional plants differing in vigour, leaf shape and colour. The frequency of such aberrant types noticed by him was from 1.3 to 4.7 per cent.

II. *Gytology:* The course of meiosis was studied in forty clonal accessions. A maximum association of $7_{IV}+2_{II}$ and minimum of 16_{II} were recorded. Two bivalents or one quadrivalent formed the nucleolar chromosomes. The metaphase plate was compact and the disjunction at AI was mostly 16/16 but 17/15 or 18/14 separations were also rarely met with. Tetrad analysis did not indicate any abnormalities.

In the deviant plant with 2n=36 chromosomes, a maximum of 9 quadrivalents was observed. The minimum number of quadrivalents formed was two ($2_{IV}+14_{II}$). The meiotic behaviour and morphological variation suggest the 32 chromosome plants to be in the nature of segmental tetraploids. In the 2n=36 plant, there is an increase of four chromosomes *i.e.* a set of chromosomes which forms a quadrivalent has been added. This could have been possible by the union of two gametes (n=18) in whose formation non-disjunction of the quadrivalents occurred. This assumption is based on the association. $1_{VI}+6_{IV}+3_{II}$.

A maximum number of 8 quadrivalents and 8 bivalents was observed in the triploid. The minimum association was represented by $1_{IV}+22_{II}$. Rarely two hexavalents were also observed in conjunction with quadrivalents, bivalents and univalents. The percentage of stainable pollen ranged from 52 to 78 per cent. It is evident that of the three genomes present, two bear greater similarity. The present study also lends support to the view of Warmke (1951) that eight is probably the basic number of the species.

Summary: Fifty one clonal accessions of *P. maximum* were studied for association of quantitative and morphological attributes related to fodder production. Inter-clonal variation was high, though there was no numerical difference in chromosomes. The variation in yield of green matter offers good scope for selection between the clones keeping in view the higher limits for leaf / stem value available.

A comparative study of the selfed and open-pollinated progenies of this species showed a high range of variability in the selfed progenies indicating the prevalence of sexuality to a high degree. This offers scope for selection in

improvement. Triploidy does not seem to confer any advantage over the diploids from the point of view of quality and quantity of fodder. A variant with 2n = 36 chromosomes detected in the seed progeny of a diploid clone was also found to be inferior in vigour or forage production to the clones with 32-chromosomes (2n). Cytologically, the diploids are in the nature of segmental tetraploids. Of the three genomes present in the triploid, two bear greater similarity and the plant with 2n = 36 chromosomes appears to be of the constitution, 2n+2+2.

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