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KARYOTYPE STUDIES IN *PANICUM MAXIMUM* JACQ

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ABSTRACT

Thirty-five accessions of Panicum maximum Jacq were collected from parts of the states of south-western Nigeria to determine the karyotype. The chromosome number is 2n = 32. They are largely sub-metacentric medium small, only chromosome pair one is submetacentric medium large. All accessions studied have symmetrical karyotype. The karyotypic pattern shows that the chromosomes can be grouped into eight groups of four and some size differentials are also recognized within each of the groups. Mitotic metaphase chromosome characters were used to assign the karyotypic formula $1C^{sm} + 15B^{sm}$ for P. maximum.

INTRODUCTION

Panicum maximum Jacq commonly known as guinea grass is of great economic importance. It is one of the most important fodder and pasture species (Bogdan, 1977) with a broad application in the tropics (Usberti and Valio, 1997). As a cultivated grass, *P. maximum* is much valued for its good persistence (Ng *et al.*, 1997) and it is one of the most successful weeds, (Batianoff and Andrew, 1998). Bogdan (1977) reported diploids 2n = 16, triploids 2n = 24, pentaploids 2n = 40, octoploids 2n = 64, nonaploids 2n = 72, and also plants with irregular chromosome numbers (2n = 31, 36, 37, 38) in *Panicum maximum*. Savidan and Pernes 1982 and Zuloaga 1987, also reported apomixis and changing ploidies in *Panicum maximum*. According to Bogdan (1977), the cultivars that are grown in various countries represent apomictic or vegetative clones with little or no variability within the cultivar. Karyotype studies in grasses are generally difficult because of preparatory problems from root tips, although the karyotype has been recognized as one of the criteria by which species could be delimited. The constancy and usefulness of the karyotype arises from the fact that at a given stage of cell division and in a given tissue, each cell of an organism has a constant number of chromosomes of reasonably definite volume, length, and shape.

Given the available information, there has not been any report on the karyotype of the accessions *of Panicum maximum* in Nigeria. The aim of this work is therefore to evaluate the mitotic metaphase chromosome morphologies and use the characters obtained there from to assign karyotypic formula to the *Panicum maximum*.

MATERIALS AND METHODS

Living plant materials were collected from wild populations in the geographical southwestern part of Nigeria, which falls within the lowland rainforest and derived savanna ecological zone, encompassing Osun, Oyo, Ogun Ondo and Kwara States. These were planted in the Botanical Garden in Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

The various accessions were brought into cultivation by transplanting rootstocks of the accessions from the wild to the experimental plot. In all, thirty-five accessions were studied. Table 1 shows the sources, locations, distinguishing characters and collectors of the accessions.

Young flower buds were harvested from the experimental field populations and fixed on the spot in 1:3 acetate:alcohol. Slides were prepared by squash technique from the tapetal cells of the anther and stained in Formic, Lactic and Propionic acid (FLP) Orcein (Lasebikan and Olorode, 1972). Good cells were photographed under the oil immersion phase contrast objective of Leitz Dialux research microscope.

Table 1. Accessions of *Panicum maximum* Jacq studied and their sources

Accession number	Location	Description	Collector
1-2	Directly behind Faculty of Agriculture Obafemi Awolowo University campus, Ile-Ife. 7°30″N 4°31″E. Nigeria	Broad leaves, heavy tillering, culm diameter fairly big. Plant type generally robust.	Adedeji & Faluyi
3	Ruderal behind Faculty of Agriculture, on the way to quarters. O.A.U, Ile-Ife, 7°30″N 4°31″E, Nigeria.	Narrow leaves, intermediate tillering, culm diameter thin. Plant type not so robust.	Adedeji & Faluyi
4-6	Inside the bush on Road 18. O.A.U. Staff quarters. Ile-Ife 7°30″N 4°31″E, Nigeria.	Mostly, broad-leafed, heavy tillering, culm diameter fairly big. Plant type robust	Adedeji & Faluyi
7-9	Ruderal on Road 18, O.A.U. Staff quarters, Ile-Ife. 7°30″N 4°31″E, Nigeria.	Narrow leaves, heavy tillering, culm diameter s Plant type not robust	Adedeji & Faluyi
10	Inside the bush on Road 8, O.A.U. Staff quarters, Ile-Ife. 7°30″N 4°31″E, Nigeria.	Broad leaves, heavy tillering, culm diameter big. Plant robust.	Adedeji & Faluyi
11	Inside Odeda quarters, Abeokuta, Ogun State. 7°10″N 3°21″E, Nigeria.	Broad leaves, heavy tillering, culm diameter big. Plant robust.	Faluyi & Nwokeocha
12	Ruderal, Abeokuta - Ibadan Road 7°15″N 3°5″E, Nigeria.	Narrow leaves, heavy tillering, culm diameter s Plant type robust	Faluyi & Nwokeocha
13	Abeokuta - Ibadan road, inside the bush 7°15″N 3°25″E, Nigeria	Narrow leaves, heavy tillering, culm diameter small. Plant robust.	Faluyi & Nwokeocha
14-15	Ruderal, Abeokuta - Ibadan road, 7°15″N 3°25″E, Nigeria.	Narrow leaves, low tillering, culm diameter small. Plant not robust.	Faluyi & Nwokeocha
16	National Cereals Research Institute (N.C.R I), Apata. Ibadan, Oyo State 7°17″N 3°30″E, Nigeria.	Broad leaves, heavy tillering, culm diameter big. Plant robust	Faluyi & Nwokeocha
17	Inside the bush, Apata, Ibadan, Oyo State 7°17″N 3°30″E. Nigeria.	Broad leaves, heavy tillering, culm diameter big. Plant robust	Faluyi & Nwokeocha
18	Ruderal, Apata, Ibadan, Oyo State. 7°17″N 3°30″E, Nigeria.	Narrow leaves, low tillering, culm diameter small. Plant type not robust.	Faluyi & Nwokeocha
19-22	Teaching and Research farm O.A.U Ile-Ife. 7°30″N' 4°31″E, Nigeria.	Broad leaves, heavy tillering, culm diameter big. Plant robust	Adedeji & Faluyi
23-24	Ruderal, Federal University of Technology, Akure (F.U.T.A) School area, Ondo State 7°15″N 5°14″E, Nigeria	Narrow leaves, low tillering, culm diameter small. Plant type not robust.	Adedeji
25	F.U.T.A. Staff quarters, Akure,. Ondo State. 7°15″N 5°14″E, Nigeria	Broad leaves, heavy tillering; culm diameter big. Plant robust	Adedeji
26	Ruderal in front of a house, F.U.T.A. Staff quarters, Akure, Ondo State 7°15″N 5°14″E, Nigeria.	Narrow leaves heavy tillering culm diameter small. Plant not so robust	Adedeji
27-28	Abandoned farmland, F.U.T., Akure, Ondo State 7°15″N 5°14″E, Nigeria.	Broad leaves, heavy tillering; culm diameter big. Plant robust	Adedeji
29	Ruderal, F.U.T., Akure Ondo State 7°15″N 5°14″E, Nigeria.	Narrow leaves, low tillering, culm diameter small. Plant type not robust.	Adedeji
30-33	Oil palm plantation Apoje, Ijebu-Igbo, Ogun State, in the open 6°58″N 4°00″E, Nigeria.	Broad leaves, heavy tillering, culm diameter big. Plant robust	Adedeji & Faluyi
34	Oil palm plantation Apoje, Ijebu-Igbo, Ogun State, in the open 6°58″N 4°00″E, Nigeria.	Narrow leaves, intermediate tillering, calm diameter small. Plant not so robust.	Adedeji & Faluyi
35	Ruderal, Ilorin-Offa road on the Kwara State - Osun State boundary 8°32″N 4°34″E Nigeria.	Narrow leaves, low tillering, culm diameter small. Plant not robust	Faluyi

Chromosome measurements were made in millimeters from photomicrographs of metaphases of tapetal cells, which were enlarged 2400X. The chromosomes were matched based on gross size, arm length and arm ratio measurements. The images of paired chromosomes were cut and arranged in order of decreasing length for recording measurements and for purposes of subsequent reference. When all measurements had been compiled, the long-to-short arm ratios (L/S), centromeric index (C.I.) and total chromosome length percentage (T.C.L. %) were calculated for the *P. maximum* genome. After pairing and comparing the chromosomes, the data were converted into microns. The means of the pairs were calculated to obtain the values for the idiograms.

In evaluating the chromosome morphology, centromeric position terminologies proposed by Abraham and Prasad (1983) were used. Depending upon their relative length, the chromosomes were assigned to size classes delimited by Stebbins (1938) as follows:

A. Short/small chromosomes (average length less than 2pm).
B. Medium small chromosomes (2- 5pm long).
C. Medium large chromosomes (5- 9pm long).
D. Large/long chromosomes (average length more than 9pm).

T.C.L. % was calculated using the formula described by Huziwara (1962).

$$\text{T.C.L. \%} = \frac{\text{Total length of a chromosome pair} \times 100}{\text{Total length of a chromosome complement}}$$

$$\text{C.I.} = \frac{\text{Short arm length} \times 100}{\text{Total chromosome length.}}$$

RESULTS AND DISCUSSIONS

Table 2 shows the classification of the chromosomes according to Abraham and Prasad (1983) and Stebbins (1938). The chromosomes are mainly sub-metacentric medium small with only chromosome pair one being sub-metacentric medium large (Plates. 1A, B, C.). The karyotypic formula proposed for *P. maximum* based on the above morphological characteristics of the chromosomes is $1C^{sm} + 15B^{sm}$. Superscript sm, represents sub-metacentric position of the centromere.

The idiogram (Plate 1C) shows the karyotype graphically. It is easy to see from this idiogram that the complement falls into 8 size class groups of one chromosome pair per size class. These size classes also fall clearly into centromere type classes. The karyotype conforms to a chromosome complement of 2n =32 for *Panicum maximum*. The karyotypic pattern of eight groups of four is consistent with the interpretation of autopolyploidy but it is not inconsistent with the postulate of segmental allopolyploidy. The karyotype is symmetrical composed of sub-metacentric chromosomes, suggesting that the species is primitive. The predominant trend is from symmetry to asymmetry, although reversals of this trend do occur periodically.

A close look at the idiogram show the eight different quadrivalent groups as being unique in. chromosome form and size signifying the ease of tetravalent associations among each group during meiosis. This however leads to meiotic irregularities, which throws light on the limitations of the reproductive biology in this species shown through very low seed set, low pollen fertility and reduced variability in the population, Adedeji, 2001.

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LITERATURE CITED

Adedeji, O. 2001. Characterization and evaluation of collections of *Panicum maximum* Jacq. in South-western Nigeria. Ph.D. Thesis, Obafemi Awolowo University, Ile-Ife, Nigeria. 139p.

Abraham, Z. and P. N. Prasad, 1983. A system of chromosome classification and nomenclature. *Cytologia* 48:95-101.

Batianoff, G. N. and J. F. Andrew, 1998. Environmental weed invasions on South-east Queensland foredunes. *Proc. of Royal Soc. of Queensland* 107:15-34.

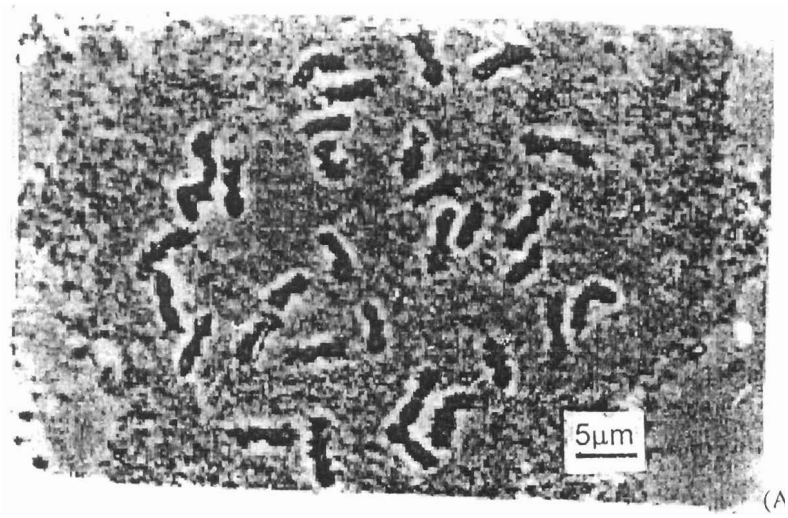
Bogdan, A. V. 1977. Tropical Pasture and Fodder Plants, Longman Publishing Co., New York, pp. 11-62.

Huziwara, Y. 1962. Karyotype analysis in some genera of Compositae. III. Further studies

Table 2. Karyotypic data of *Panicum maximum*

Chromosome Pair Number	S (± s.d.) (µm)	L (±s.d.) (µm)	S + L (±s.d.) (µm)	TCL %	Arm Ratio (LS)	C.L	C.T.
1	2.40±0.11	2.82±0.11	5.22±021	8.15	1.18	45.98	C
2	2.04±0.04	2.88±0.11	4.92±0.42	7.68	1.41	41.46	B
3	2.04±0.04	2.82±0.05	4.86±0.39	7.59	1.38	41.98	B
4	1.98±0.10	2.80±0.00	4.78±0.41	7.46	1.41	41.42	B
5	1.75±0.04	2.52±0.02	4.27±0.39	6.66	1.44	40.98	B
6	1.74±0.00	2.52±0.02	4.26±0.39	6.65	1.45	40.85	B
7	1.73±0.00	2.53±0.11	4.26±0.40	6.65	1.46	40.61	B
8	1.70±0.00	2.55±0.11	4.25±0.43	6.63	1.50	40.00	B
9	1.63±0.05	2.40±0.11	4.03±0.39	6.29	1.47	40.45	B
10	1.67±0.00	2.04±0.04	3.71±0.26	5.79	1.22	45.01	B
11	1.52±0.06	1.92±0.17	3.44±0.20	5.37	1.26	44.19	B
12	1.40±007	1.94±0.96	3.34±0.27	5.21	1.39	41.92	B
13	1.17±013	2 12±0.07	3.29±0.48	5.13	1.81	35.56	B
14	1.25±0.11	1.93±0.15	3.18±0.31	4.96	1.54	39.31	B
15	1.25±0.08	1.89±0.36	3.14±0.32	4.90	1.51	39.81	B
16	1.21±0.04	1.92±0.17	3.13±0.36	4.88	1.59	38.66	B
Σ	26.48	37.60	64.08	100.00			
(±s.d.)	1.66±0.09	2.35±0.09	4.00±0.18	6.25±0.27	1.44±0.04	41.14±0.63	

S = Short arm length (± s.d.)
L = Long arm length (± s.d.)
S+L = Total chromosome length (± s.d.)
TCL% = Total chromosome length percentage (S+L/Σ(S+L))X100
C.L. = Centromeric index = (S/S+L) X 100
C.T. = Chromosome type: B or C
Sub-metacentric medium small = B = (2.5µm long)
Sub-metacentric medium large = C = (5-9µm long)



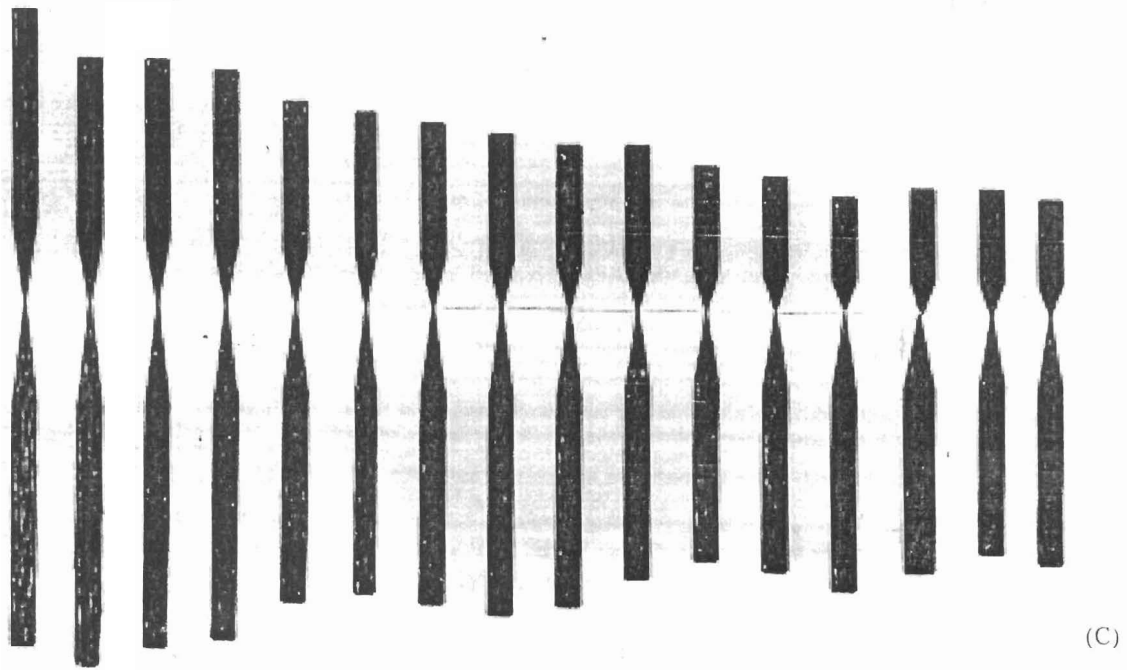


Plate 1. (A) Mitotic metaphase chromosomes in *Panicum maximum*
(B) Karyotype of the accessions of *Panicum maximum*
(C) Idiogram showing the haploid chromosome complement of the *Panicum maximum* accessions studied

genera of Compositae. III. Further studies on the chromosomes of *Aster*. *Amer. J. Bot.* 49(2):116-119.

ibikan, A. B. and O. Olorode, 1972. Morphological variation and cytological aberrations in natural populations of *Zonocerus variegatus* L. (Orthoptera: Pyrgomorphidae). *Bull. Entomol. Soc. of Nig.* 3:127-133.

Ng. K. F., W. W. Stur and H: M. Shelton, 1997. New forage species for integration of sheep in rubber plantations. *J. Agric. Sci.* 128 (3):347-355.

idan, Y and J. Pernes, 1982. Tetraploid-Dihaploid cycles and the Evolution of *Panicum maximum* Jacq. *Evolution* 36:596-600.

Stebbins, G. L. 1938. Cytological characteristic associated with different growth habits in the dicotyledons. *Amer. J. of Bot.* 25:189-198.

Usberti, R. and I. F. M. Vslio. 1997. Osmoconditioning effects on germination of guinea grass (*Panicum maximum*) seeds. *Seed Sci. and Tech.* 25(2):303-310.

Zuloaga, F. O. 1987. Systematics of New World species of *Panicum* (Poaceae: Paniceae). In: *Grass Systematics and Evolution.* (eds. Soderstrom, T. *et. al.*). pp.287-306.