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Morphological, Agrobotanical and Reproductive Studies in 35 Accessions of *Panicum maximum* Jacq. in South Western Nigeria

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Abstract: *Panicum maximum* Jacq. in Southwestern Nigeria occur in two distinct field forms. Thirty-five accessions representing these two field forms were collected and studied for their morphological, agrobotanical and reproductive biology characters. The plant is observed to be an aggressive colonizer. It flowers early as days to first heading range from 45-93 days. They are poor seeders and propagation is predominantly vegetative: through root-stocks and roots from the nodes. The variations in mean pollen size and percentage fertility emphasize the influence of genetic factors on pollen size and fertility. Pollen fertility is low in all the accessions studied.

Key words: Agrobotanical, reproductive biology, field forms, pollen fertility

Introduction

Panicum maximum Jacq. commonly known as guinea grass is one of the most important fodder and pasture species (Bogdan, 1977). As a cultivated grass, it is much valued for its good persistence (Ng *et al*., 1977). It is one of the most successful weeds (Batianoff and Andrew, 1998) and also a good colonizer (Boonman, 1993; Martinez *et al*., 1997). It belongs to the tribe Paniceae, subfamily Panicoideae in the family Poaceae.

Panicum maximum is widespread throughout Southern Nigeria, on roadsides, waste places and in the wetter parts of the North (Stanfield, 1970). It is a very variable species in East Africa and numerous natural types exist, some of which have been described as botanical varieties. Two main groups differing in their agronomical characteristics can be distinguished.

- Large or medium types suitable for both silage and grazing, they can be economically established from tuft splits at 5,00-10,000 splits per ha.
- Small, low-grazing types suitable mainly for grazing, which should be grown close and can be established on a farm scale only or mainly from seed; some of them are, fortunately, reasonably good seeders.

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. Most of these known cultivars are large- sized forms.

Apart from the fact that seed formation in guinea grass is generally poor, seed shattering which is a common feature in tropical pasture plant is another serious economic problem (Sanada and Hidemichi, 1998). According to Mariano (1986), *P. maximum* seeds are dispersed from the plant in a state of innate dormancy.

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Panicum maximum in southwestern Nigeria occur in two field forms: the heavy-tillering, robust, tall, long and broad-leafed with relative fat culm and the low-tillering, not so robust, moderately tall, not so long and narrow-leafed with thin culms. This plant has not been studied through the two field forms. Information on the morphological, agrobotanical and reproductive biology is also scanty. This study is planned to redress these knowledge gaps.

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, Awolowo University, Ile-Ife (7°33'N 4°34'E), Osun State, Nigeria, monitored and studied over a 3 year period (2000-2003).

The various accessions were brought into cultivation by transplanting root-stocks of the accessions from the wild to the experimental plot. In all, 35 accessions were studied.

Morphological and Agrobotanical Studies

Measurements of quantitative and assessment of qualitative morphological characters were taken for all the accessions at maturity on the following attributes:

- Plant type
- Habit
- **Height** - measured on main culm from soil level to base of panicle after heading.
- Panicle - type, length.
- **Spikelet** - number per panicle, shattering, length, width, spikelet pericarp colour, stigma colour and anther colour.

Number of spikelets per panicle was estimated as:

$$\frac{L-(n\times x)}{10\ cm}\times S$$

Where, L = Total length of primary branches
n = Number of primary branches
x = Mean of the total length of regions bearing no spikelets on 10 primary branches
S = Number of spikelets per 10 cm primary branch length.

Estimates were also made through physical counting. Small pore nets were used to cover the panicles so that the shattered spikelets could be collected for more accurate counting.

Leaf
a) Flag leaf - shape, tip, length and width measurements
b) Leaf below flag - shape, tip, pubescence, colour, length and width measurements
c) Ligule - type and colour.

Photographs of major plant forms were taken.

Pollen grains were harvested by teasing matured or just-dehisced anthers on to microscope slides. The pollen grains were stained in cotton blue in lactophenol. Three slides were prepared for each

accession. The pollen grains were scored for stainability at 100X magnification and percent stainability calculated. Well formed (round) intact and uniformly stained pollen grains were considered viable while those that were only partially stained or not stained at all and with collapsed outlines were scored as non-viable (Jackson, 1962; Olorode and Baquar, 1976). The diameter of pollen grains was measured at 400X in ocular units and later converted to micrometer. Estimate of mean pollen size was based on measurements of 50 pollen grains for each accession.

Reproductive Biology Studies

This was done by excising four tillers from the root stocks of twenty of the accessions in the nursery (all areas of collection were represented) and transplanting them on the same day using a Randomized Complete Block Design with 3 replicates each for the twenty accessions. After 2 weeks of transplanting, all tillers were clipped down to a height of 5 cm above ground level. At sexual maturity, about six and a half weeks after initial pruning; readings were taken for 5 reproductive biology parameters according to Ene-Obong and Omaliko (1986) as follow:

- Days to first heading
- Days to 50% heading
- Heading height
- Number of spikelets per head.
- Seedling recruitment: estimated as total number of seedlings divided by total quadrat area in 5 years.

Results

Morphological Studies

Habitat/Habit

The accessions of *Panicum maximum* were found on roadsides, farmlands, waste places, abandoned lands; in fact they thrive on all lands where there is enough soil for them to grow. They grow well in the open and under the shade. Some very large populations were encountered. General observations on the field showed that regeneration and spread is mainly through rootstocks and adventitious roots from the nodes. They compete well with other plants; they are in fact so aggressive that they colonise habitats within a short time. This is the situation at the Obafemi Awolowo University, Ile-Ife, Nigeria Teaching and Research farm that first had *Chromolaena odorata* (Linn.) King and Robinson as its main plant cover but has now been largely displaced by *P. maximum*.

The accessions of *P. maximum* studied were all perennials. New tillers regenerated from rootstocks of old plants at the beginning of the rains. Observations in the field showed that fire does not destroy the rootstocks. This is of course true of other grasses like *Andropogon, Hyparrhenia* and *Pennisetum* which regenerate from the rootstocks immediately after the first rains.

Plant Types

The accessions studied were mainly erect and open, some tillers lodging to the ground at maturity, most especially after heavy wind (Fig. 2A and B). Plant types were observed on the field and in the nursery at the first rainy season after planting. Two plant types were observed on the field. The first type is open, tall, about 198-257 cm in height, culms relatively fat (1.58-1.95 cm) with long (56.91-82.43 cm) and broad leaves (2.84-3.81 cm). The plants are robust and heavy tillering (56-102 tillers per plant; Fig. 1A, Table 1).

Table 1: Quantitative vegetative-morphological features of the accessions studied

Field

		Culm		Flag leaf		Leaf below	
Acc.No.	No.	L (cm)	D (cm)	L (cm)	W (cm)	L (cm)	W(cm)
1	102	198±3.59	1.87±0.04	27.91±3.77	2.84±0.19	75.07±4.19	3.67±0.13
2	100	226.4±13.89	1.86±0.06	33.72±4.00	2.98±0.13	82.43±4.47	3.81±0.05
3	61	182.0±5.23	0.91±0.04	15.47± 1.79	1.73±0.14	51.73±3.34	2.23±0.10
4	76	251.5±10.17	1.75±0.11	28.05±3.52	2.40±0.23	71.39±6.06	3.44±0.10
5	85	243.8±12.10	1.95±0.04	25.57±2.32	2.58±0.13	56.91±3.74	3.40±0.22
6	102	238.0±7.64	1.82±0.05	21.90±2.88	2.15±0.18	65.69±4.13	3.41±0.11
7	92	201.3±4.74	1.14±0.07	18.41±1.80	1.93±0.12	50.39±4.80	2.34±0.05
8	90	197.2±4.62	1.21±0.09	17.75±2.02	1.54±0.17	48.83±4.99	2.18±0.07
9	78	179.2±5.33	1.18±0.07	17.77±2.46	1.76±0.18	53.10±5.26	2.38±0.04
10	101	243.5±11.13	1.84±0.07	27.37±2.59	2.53±0.13	80.90±4.92	3.33±0.11
11	90	237.5±8.27	1.58±0.04	25.67±2.54	2.44±0.15	62.73±4.75	3.08±0.10
12	81	195.5±9.73	1.06±0.07	19.23±2.35	2.00±0.13	54.26±2.90	2.29±0.08
13	78	210.20±6.40	1.09±0.07	21.32±2.53	1.74±0.17	55.20±4.05	2.23±0.06
14	48	186.0±10.66	1.02±0.05	24.37±2.29	1. 69±0.19	56.33±3.75	2.25±0.10
15	41	201.5± 10.65	1.03±0.06	24.02±2.84	1.89±0.17	57.23±3.60	2.16±0.06
16	82	250.5±9.11	1.88±0.06	23.0±2.18	2.34±0.14	60.35±6.11	2.92±0.20
17	80	231.0±8.69	1.81±0.06	24.70±2.24	2.35±0.13	65.17±3.60	3.33±0.15
18	38	211.9±9.78	1.15±0.03	19.65±2.30	1. 90±0.14	40.44±5.11	2.52±0.17
19	74	226.9±8.67	1.64±0.06	26.04±3.13	2.54±0.15	63.74±3.72	3.42±0.13
20	88	230.2±9.59	1.63±0.08	25.73±2.33	2.23±0.17	57.85±3.66	3.07±0.18
21	88	203.5±5.58	1.85±0.05	27.64±2.77	2.44±0.17	57.45±3.29	3.28±0.14
22	90	225.7±11.86	1.78±0.05	32.88±2.79	2.75±0.14	69.49±3.57	3.52±0.13
23	28	197.7±9.01	1.16±0.06	22.53±3.44	1.74±0.20	59.01±4.07	2.07±0.05
24	44	202.0±9.01	1.18±0.05	20.87±2.68	1.75±0.18	59.52±3.03	2.17±0.06
25	72	255.0±7.11	1.89±0.05	25.90±2.32	2.68±0.12	60.47±4.43	3.50±0.15
26	74	218.0±6.14	1.21±0.03	24.81±1.87	2.02±0.04	51.89±5.09	2.17±0.06
27	81	225.0±4.53	1.80±0.03	25.91±2.82	2.77±0.01	78.44±4.28	3.18±0.11
28	70	210.00±5.02	1.90±0.03	33.37±3.90	2.87±0.18	66.34±4.60	3.19±0.15
29	35	207.7±5.66	1.10±0.04	22.26±2.24	1.97±0.14	64.05±4.60	2.21±0.08
30	66	215.3±8.05	1.76±0.04	21.24±2.23	2.31±0.21	68.49±4.46	3.26±0.16
31	70	220.3±5.24	1.75±0.03	22.03±4.21	2.32±0.21	66.55±4.09	3.37±0.12
32	60	219.9±8.08	1.81±0.04	24.77±2.72	2.37±0.20	62. 79±6.66	3.25±0.14
33	56	257.0±6.33	1.74±0.02	29.1±2.46	2.48±0.11	63.52±4.04	2.84±0.09
34	52	194.0±4.20	1.21±0.03	21.62±2.03	1.96±0.18	58.18±3.28	2.46±0.07
35	31	194.5±4.45	1.2 1±0.03	20.03±2.73	1.57±0.19	58.35±1.94	2.31±0.06

Nursery

		Culm		Flag leaf		Leaf below	
Acc No.	No.	L (cm)	D (cm)	L (cm)	W (cm)	L (cm)	W (cm)
1	91	2358±9.57	1.93±0.04	27.30±4.09	2.63±0.26	80.54±4.59	3.61±0.14
2	115	247.5±13.00	1.95±0.05	34.60±3.96	2.92±0.20	86.30±3.87	3.91±0.09
3	84	230.7±10.3	1.78±0.05	25.80±3.55	2.45±0.23	67.87±7.35	3.60±0.13
4	90	279.4±8.47	2.00±0.04	25.50±4.06	2.19±0.29	68.51±8.10	3.49±0.12
5	90	271.6±14.5	1.93±0.05	25.07±2.36	2.54±0.14	64.42±5.85	3.58±0.18
6	110	269.4±6.25	1.92±0.04	25.68±3.40	2.18±0.17	72.11±4.58	3.53±0.15
7	101	234.5±8.15	1.50±0.07	25.85±1.96	2.32±0.15	56.33±4.29	3.26±0.08
8	95	234.2±12.20	1.37±0.1 0	23.64±3.10	2.31±0.18	63.00±4.69	3.06±0.11
9	85	246.2±7.75	1.80±0.04	25.63±2.38	2.19±0.09	63.52±3.88	3.20±0.12
10	98	275.2±6.96	1.87±0.06	31.10±3.86	2.54±0.15	78.45±3.91	3.78±0.09
11	98	265.0±14.85	1.83±0.05	26.88±3.17	2.38±0.20	73.16±5.30	3.22±0.11
12	92	272.0±12.98	1.43±0.04	29.00±2.93	2.44±0.14	79.70±3.84	3.34±0.12
13	89	253.5±9.63	1.67±0.07	30.64±3.41	2.85±0.14	76.33±6.31	3.70±0.15
14	84	272.5±7.00	1.64±0.05	27.59±2.31	2.45±0.17	67.37±4.79	2.81±0.24
15	78	259.0±12.42	1.92±0.04	32.02±2.13	2.34±0.07	73.04±3.45	3.01±0.13
16	98	265.2±10.10	1.93±0.05	28.23±2.44	2.65±0.21	75.89±5.81	3.55±0.16
17	88	254.5±9.02	1.75±0.05	29.87±3.25	2.72±0.10	81.33±5.02	3.16±0.12
18	92	287.5±7.86	1.83±0.04	26.83±2.12	2.46±0.17	67.57±3.42	3.12±0.10
19	86	231.4±10.18	1.79±0.10	30.44±3.34	2.75±0.14	78.55±4.94	3.72±0.10

Table 1: Continued

Acc No.	Nursery No.	Culm L (cm)	Culm D (cm)	Flag leaf L (cm)	Flag leaf W (cm)	Leaf below L (cm)	Leaf below W (cm)
20	82	245.5±10.39	1.85±0.03	32.21±4.01	2.77±0.20	71.00±6.48	3.61±0.14
21	102	230.0±8.82	1.84±0.05	28.21±4.60	2.41±0.29	71.57±6.36	3.32±0.13
22	105	251.00±4.34	1.80±0.03	36.94±3.76	2.73±0.13	69.40±8.94	3.44±0.13
23	84	263.6±6.13	1.72±0.05	28.25±3.58	2.63±0.24	65.98±8.74	3.35±0.08
24	100	259.4±9.99	1.90±0.06	29.17±2.56	2.36±0.10	72.38±4.80	3.52±0.09
25	110	279.0±9.30	1.91±0.05	30.50±3.30	2.70±0.21	69.10±4.15	3.56±0.12
26	99	260.5±9.25	1.85±0.03	23.15±2.81	2.24±0.26	65.40±4.76	3.00±0.21
27	101	255.50±7.40	1.95±0.05	27.29±1.84	2.39±0.19	63.28±3.56	3.10±0.17
28	82	256.10±5.76	1.90±0.03	30.37±3.73	2.69±0.14	72.64±5.10	3.54±0.14
29	105	265.5±10.99	1.39±0.04	34.85±4.08	2.67±0.17	73.45±3.68	3.63±0.12
30	98	237.7±7.55	1.79±0.03	32.91±3.46	2.56±0.14	74.27±5.51	3.55±0.11
31	95	240.4±9.13	1.89±0.04	27.61±2.97	2.53±0.13	74.88±4.92	3.65±0.14
32	101	259.0±12.49	1.84±0.05	35.52±3.63	2.55±0.14	70.52±4.62	3.51±0.13
33	74	250.0±9.37	1.87±0.05	31.75±3.73	2.50±0.17	67.65±4.62	3.32±0.10
34	88	232.5±10.01	1.31±0.03	23.77±2.83	1.96±0.16	60.89±4.68	2.90±0.09
35	66	222.0±7.97	1.24±0.05	27.00±2.90	1.81±0.20	55.65±3.48	2.67±0.14

Acc. No. Accession No. Number., L, Length., W, Width., D, Diameter

Table 2: Floral attributes of the accessions of *Panicum maximum* studied

Acc. No.	Panicle Length (cm)	No. of 1° Branches	Spikelets No/Panicle	Shattering	Length (mm)	Width (mm)	Pericarp Colour	Nature of end
1	55.80±2.27	35-60	3,533-4,619	+	2.81±0.10	0.98±0.01	Brown	Blunt
2	57.16±3.00	48-61	3,608-5,074	+	2.90±0.08	0.95±0.02	"	"
3	56.76±2.19	35-60	2,964-4,824	+	2.84±0.10	0.95±0.01	"	"
4	60.86±2.21	45-62	3,844-5,562	+	2.70±0.09	0.97±0.02	"	"
5	60.48±3.76	46-61	3,967-5,034	+	2.75±0.12	0.96±0.02	"	"
6	62.98±2.09	41-58	3,624-4,908	+	2.81±0.08	0.99±0.01	"	"
7	52.0±2.48	44-64	4,009-6,491	+	2.85±0.07	1.02±0.01	"	"
8	50.58±3.69	45-60	4,024-6,220	+	2.84±0.07	0.98±0.01	"	"
9	54.8±2.41	40-62	3,968-4,550	+	2.82±0.07	1.00±0.01	"	"
10	62.36±2.26	40-63	3,664-6,440	+	2.70±0.08	0.97±0.02	"	"
11	61.64±1.75	45-60	4,258-6,605	+	2.75±0.07	1.00±0.01	"	"
12	52.76±2.60	48-61	4,968-5,998	+	3.57±0.09	1.00±0.01	"	
13	51.94±4.00	40-59	3,682-4,912	+	3.30±0.11	1.00±0.01	"	
14	61.84±2.93	51-61	6,221-8,094	+	3.31±0.14	0.97±0.01	"	
15	60.66±3.67	30-64	2,454-4,345	+	2.85±0.08	1.00±0.01	"	
16	60.1±5.01	44-62	4,059-6,024	+	2.74±0.06	0.99±0.01	"	
17	62.18±4.20	51-70	5,552-8,071	+	2.81±0.08	0.99±0.02	"	
18	59.06±6.11	50-63	4,989-6,223	+	3.59±0.10	1.02±0.01	"	
19	58.96±5.17	48-67	5,021-7,112	+	2.78±0.11	0.98±0.01	"	"
20	60.88±3.27	48-65	4,992-6,044	+	2.82±0.09	0.99±0.01	"	"
21	60.54±3.65	51-67	5,644-7,002	+	2.70±0.07	1.00±0.01	"	"
22	62.44±4.03	47-69	4,443-6,742	+	2.80±0.06	1.01±0.01	"	"
23	58.06±3.95	46-56	3,926-4,564	+	2.91±0.07	0.99±0.02	"	"
24	51.42±2.58	40-55	2,976-4,023	+	2.88±0.07	1.00±0.01	"	"
25	62.68±2.86	44-62	3,020-4,058	+	2.89±0.06	1.02±0.01	"	"
26	56.22±2.97	38-57	2,441-3,792	+	3.31±0.14	1.00±0.01	"	"
27	59.32±2.87	44-60	2,991-4,341	+	3.31±0.10	1.00±0.00	"	"
28	59.98±2.32	41-60	3,218-5,402	+	2.84±0.10	1.01±0.01	"	"
29	55.68±2.22	39-56	3,011-5,052	+	2.80±0.09	0.99±0.02	"	"
30	59.16±2.71	44-70	3,401-6,720	+	3.50±0.13	0.97±0.02	"	"
31	60.64±1.19	44-70	3,042-6,422	+	2.86±0.07	0.98±0.02	"	"
32	60.70±2.65	46-58	4,009-5,064	+	2.75±0.09	0.97±0.02	"	"
33	60.98±2.85	49-56	5,024-5,882	+	2.80±0.07	0.99±0.02	"	"
34	55.96±1.67	38-47	3,002-4,998	+	3.25±0.09	0.99±0.01	"	"
35	55.54±2.17	35-48	2,556-4,665	+	2.96±0.04	0.99±0.01	"	

Table 2: Continued

Acc. No.	Stigma colour	Anther colour	Pollen fertility (%)	Pollen grain size (μm)
1	Purple	Yellowish-brown	40.5	42.37±1.50
2	"	"	38.8	42.73±2.07
3	"	"	**44.4**	**40.15±1.56**
4	"	"	37.6	41.28±1.66
5	"	"	35.5	43.68±1.27
6	"	"	41.4	46.83±1.83
7	"	"	50.3	45.33±1.66
8	"	"	48.2	42.55±1.43
9	"	"	34.4	44.59±2.00
10	"	"	27.5	41.26±1.66
11	"	"	25.7	49.95±2.37
12	"	"	34.6	43.66±2.62
13	"	"	24.4	43.29±2.21
14	"	"	36.7	42.55±2.59
15	"	"	30.3	40.91±1.39
16	"	"	40.5	40.70±1.74
17	"	"	38.1	44.03±1.91
18	"	"	29.4	38.48±1.70
19	"	"	32.2	49.03±2.75
20	"	"	34.3	45.88±2.04
21	"	"	26.7	44.96±1.59
22	"	"	35.4	42.92±1.48
23	"	"	40.5	45.70±1.14
24	"	"	30.2	46.81±1.51
25	"	"	32.3	49.95±1.65
26	"	"	27.8	51.62±1.71
27	"	"	38.1	45.88±1.51
28	"	"	40.6	45.34±1.21
29	"	"	35.4	42.55±1.26
30	"	"	30.2	45.14±1.56
31	"	"	37.3	46.99±1.52
32	"	"	25.5	50.51±1.14
33	"	"	22.6	47.92±1.62
34	"	"	28.4	45.33±1.41
35	"	"	29.7	**48.29+ 1.15**

Acc. Accession., No. Number., 1° Primary

The second type is open, moderately tall, 182-218 cm in height, culm diameter is comparatively thin (0.91-1.21 cm) with not so long (40.44-64.05 cm) and narrow leaves (2.07-2.52 cm). Tillering is moderately heavy or low (28-92 tillers per plant stand (Fig. 1 B, Table 1). The two types could be found growing together or form distinct isolated populations.

Observations in the Nursery at the first rainy season after planting showed that the open moderately tall plant type had almost disappeared. Below-the-flag-leaf lengths and breadths; culm lengths and diameters were compared for the field and nursery plantings. Generally, leaves were longer in the nursery plantings than in the field plantings. The only slight exceptions to that trend are accessions 4, 10, 27 and 35. In accession 22, the leaves in the nursery are as long as on the field.

Below-the-flag leaf breadths in the field and nursery plantings showed that leaves were generally broader in the nursery plantings than on the field. However, exceptions occur in 4 accessions: 1, 17, 22 and 27, although it can be seen that the differences are only slight. Of particular interest is the fact that accessions 3, 7, 8, 9, 12, 13, 14, 15, 23, 24, 26, 29, 34 and 35 that were narrow-leafed on the field had reverted to broad-leafed in the nursery plantings, though accessions 14, 34 and 35 were not as broad as others. Culms were generally longer in nursery than field plantings with only one exception in accession 33, but the difference is minimal. Comparative culm diameters revealed that 31 accessions out of the 35 had bigger culms or tillers in the nursery plantings than on the field. Exception occurred in accessions 5, 17 and 21. Accession 28 had about the same culm diameter in the field and nursery plantings

Fig. 1: The two field forms in *Panicum maximum*, A: The open, tall, relatively fat culms with long and broad leaves. B: The open, moderately tall, culms diameter comparatively thin with not so long and narrow leaves

Agrobotanical Studies

The leaves in accessions of the two plant types are green in colour, glabrous, shape lanceolate to occasionally linear-lanceolate in the small types, tip acuminate. The lower outer sheath is green with purple tinge while the inner sheath is white in colour. The ligule is a fringe of hairs and it is greyish-white. The panicle is open with primary, secondary and tertiary branches. It is 50.58-62.98 cm long (Table 2). It is shortest in accession 8 and longest in accession 6. The number of primary branches is lowest in accession 15, (30 in number) and highest in accessions 17, 30 and 31 (70 in number) (Table 2).

The spikelet number per panicle range from 2,441-8,094 (Table 2) the lowest value occurring in accession 26 and the highest occurring in accession 14. This high number of spikelet production was observed to be mainly due to the usually long panicles and the presence of secondary and tertiary branches on which the spikelets are often densely arranged. It was also observed that the spikelets shatter easily. This habit is aided by strong wind and agitation by birds and big grasshoppers.

The spikelets are longest, 3.59 mm in accession 18 and shortest (2.70 mm) in accessions 4, 10 and 21. They are widest (1.02 mm) in accessions 7, 18 and 25 and narrowest (0.95 mm) in accessions 2 and 3, spikelet pericarp colour is brown; the spikelets ends are blunt. Stigma colour is purple and the anther is yellowish-brown.

Fig. 2: Plant lodging and adventitious root forms in *Panicum maximum*, A: Some tillers lodging, some still erect. B: Adventitious root forms. (Arrow indicate the adventitious roots)

Table 3: Aspects of reproductive biology of representatives of the accessions studied

Accession No.	Days to 1st heading	Days to 50% heading	Heading height (cm)	No. of Spikelets per head
1	51	52	260.97±4.99	3,532 (3,952.33±336.65) 4,618
5	49	53	260.63±4.23	3,967 (4,341.33±347.20) 5,035
6	52	53	266.83±6.56	4,644 (5,537.67±695.22) 6,907
7	48	52	261.03±4.87	4,009 (6,318.33±1295.64) 8,491
11	47	52	266.4±5.20	6,470 (6,997.33±461,48) 7,917
12	86	94	294.47±7.45	5,724 (6,517.33±649.14) 7,804
14	64	87	298.87±8.78	6,524 (7,419.67±506.95) 8,279
15	53	54	260.0±13.29	4,344 (4,784.67±340.22) 5,454
16	56	57	2$1.83±6.19	4,058 (5,824.00±920.59) 7,158
18	81	85	322.50±7.05	4,989 (7,449.00±1519.06) 10,223
23	49	52	268.67±5.58	4,334 (6,019.33±917.13) 7,489
24	50	52	287.40±6.13	5,232 (6,761.33±798.11) 7,922
25	46	52	294.13±8.98	4,036 (4,974.67±528.81) 5,866
26	59	60	264.8±7.09	4,034 (4,784.67±657.96) 6,096
30	49	53	265.77±5.58	3,994 (6,981.33±1,666.74) 9,756
31	45	59	308.97±6.18	7,777 (8,874.00±657.66)10,051
32	50	56	253.70±4.32	6,842 (7,609.00±383.56) 8,004
33	93	99	306.63±8.28	2,174 (3,976.00±333.21) 4,011
34	47	61	251.1±4.88	4,534 (4,805.00±245.46) 5,295
35	46	47	245.1±6.24	3,599 (3,807.33±122.15) 4,022

Seedling recruitment is 3 seedlings in 12.5 m^2 in 5 years

Pollen grain is smallest (38.48 µm) in accession 18 and biggest (51.62 µm) in accession 26. Pollen fertility in all the accessions studied range from 22.6-50.3% with accession 33 representing the lower limit and accession 7 representing the upper limit (Table 2).

All the accessions studied root profusely at the nodes at maturity (Fig. 2B). This enhances their ability to propagate vegetatively.

Aspects of Reproductive Biology

Days to first heading range from 45-93 days, about 6½ - 13 weeks with accession 31 having the lowest and accession 33 the highest number of days (Table 3). Days to 50% heading also range from 47 to 99, about 7-14 weeks with accession 35 having the lowest and accession 33 again having the highest number. Accession 33 also has the least number of spikelets per head while accessions 18 and 31 have the highest (Table 3). Heading height range from 245.10 cm in accession 35 to 322.50 cm in accession 18.

Seedling recruitment from the soil on the field after 5 years of planting is estimated as 3 seedlings in 12.5 m^{-2} area.

Discussion

This study has revealed that *Panicum maximum* is widely distributed in Southwestern Nigeria. It can be found as ruderals, in waste places, on abandoned and cultivated farmlands, on river banks and on hills or rocky grounds where there is enough soil to support their growth. It is an aggressive colonizer and it has succeeded in displacing other plant species in its areas of occurrence. A good example of the massive colonizing effect of *P. maximum* can be seen on the campus of the Obafemi Awolowo University, Ile-Ife, Nigeria where it has overgrown the lawns which were originally planted with *Axonopus compressus*. The same event has taken place in the Teaching and Research Farm of the University where *P. maximum* has become the dominant cover of fallow lands.

Adegbite (1991) observed that the occurrence of *Aspilia africana* (Pers.) Adams in large populations at maturity (or flowering stage) was due largely to its ability to spread by vegetative propagation whereby few stands of the plant could spread particularly by vegetating from a progressively enlarging rootstock especially during the growing season. *P. maximum* not only enlarges from the rootstock rapidly but also spreads fast through the vegetative roots which they produce at the nodes. This is the principal way the plant spreads because the seed set is very poor.

The accessions collected fall into two field forms: the very robust, heavy tillering type with broad leaves and big culm diameter and the not-so-robust, low or occasionally heavy tillering type with narrow leaves and thin culm diameter. The two forms occurred frequently enough and may be sympatric. It was observed that in the nursery under the same environment and at the first rainy season after planting, the second field form had reverted to the first field form, indicating that the difference in forms initially observed was more environmental than genetic. This is a major discovery in this study.

According to Bogdan (1977), two types of *P. maximum* can be distinguished in its area of origin. firstly, large to moderately large types established from tuft splits and secondly, the small low-grazing type which can be established on a farm scale mainly from seed and are reasonably good seeders. He was of the view that cultivars that are transferred to and grown in various countries represent either apomictic or vegetative clones with little or no variability within the cultivars. The accessions in this study fall into the first type of Bogdan (1977).

The results of the agrobotanical and reproductive biology reveal that seed production in the accessions of *Panicum maximum* studied is very, very low. Seedling recruitment is also very low as was observed in this study (3 seedlings in 12.5 m^{-2}) after 5 years of planting. To make propagation

through seeds more difficult, spikelet shattering which is a serious economic problem for seed production (Sanada and Hidemichi, 1998) is of high occurrence in the accessions of *P. maximum* studied. The formula devised for the estimation of the spikelet number was checked and found to be highly reliable. This formula ensured that the effect of shattering did not adversely affect the estimation of spikelet numbers of the panicles in all the accessions studied. This formula derivation is a major contribution of this study.

The importance of pollen grain size and morphology in the characterization of plant species has been understood for some time now. Clausen (1962) reported the use of pollen size as a reliable characteristic for distinguishing two species of *Betula*. Adedeji (2005) also used pollen size to separate 3 species of *Emilia*. The observed variations in mean pollen size and percentage fertility emphasize the influence of genetic factors on pollen size and fertility. All the accessions showed considerable overlap in their pollen size range and fertility. Pollen fertility is generally low in all the accessions. This is not unexpected in view of the irregularity of meiosis observed in them (Adedeji, 2001).

Panicum flowers early as days to first heading range from 45-93 days, that is, about 6½ - 13 weeks. Propagation in *P. maximum* is predominantly vegetative. The nodes of each tiller or culm root at maturity and lodge, falling to the ground (Fig. 2A and B) where the root becomes established immediately and gives rise to a new plant stand. The vegetative propagation is by producing new plants from established rooted nodes that get detached from the parent plant.

A tiller or culm can have up to 8 nodes and each one has the ability of giving rise to a new plant stand which means that from a tiller, up to 8 new plants can arise. For a plant stand with 100 tillers, it means at maturity, the plant stand has the ability of giving rise to 800 new plant stands. The high reproductive capacity for vegetative propagation in addition to the perennial habit confer considerable adaptive advantage on *Panicum maximum* and also contribute to its success as a colonizing species in Nigeria.

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