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Characterization of *Digitaria Exilis* (Kipp.) Stapf and D. *Iburua* Stapf Accessions.

A. A. Aliero* and J. A. Morakinyo
Department of Biological Sciences
University of Ilorin, Ilorin.

ABSTRACT

Ten collections of Digitaria consisting of eight Digitaria exilis and two D. iburua accessions were characterized using vegetative, floral and spikelet characters and evaluated for yield. The accessions differ significantly with respect to qualitative and quantitative attributes. The placement of Tsunshalla in D. exilis was questionable because of its striking resemblance to D. iburua in many respects except absence of leaf sheath pubescence as in D. exilis. The high pollen fertility and seed set suggest normal sporogenesis and high male arid female fertility. The pollen grains of the ten accessions were small and medium pollen types based on pollen diameter measurement. The pollen grains size range from 10-20 μm for small and 25-50 μm for medium categories in D. exilis and D. iburua respectively. The pollen diameter could be of taxonomic significance in delimiting two species in this study.

**Present address: Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto*

INTRODUCTION

In Nigeria, the cultivation of *Digitaria exilis* (Kipp) Stapf and *D. iburua* Stapf are restricted to states of the Northern part of the country particularly Bauchi, Kaduna, Plateau, Federal Capital Territory, Borno and Niger States. *D. exilis* and D. *iburua* are grown as cereal food crops by the Hausa tribe of Northern Nigeria (Stanfied, 1976) *D. exilis* and *D. iburua* commonly called Acha (Hausa) or hungry rice are generally unimproved. The crops are not grown outside Africa. Very little archeological evidence exists on it (Harlan, 1989). Their cultivation dates back to 5000 BC and they are probably the oldest African cereals (Pulseglove, 1972).

The utilization of *Digitaria* species for food or for other uses is largely restricted to areas of production. The food values of *Digitaria* have been reported by Seetharam *et al.* (1986). *D. exilis* composed of 8.3g protein, 3.8g fat, 3.8g minerals, fibre 8.5g and 73.6g carbohydrate per 100g. Gottschalk and Wolff (1983) reported that carbohydrate and protein are the dominant compounds found in seeds while lipids and other substances are also present. *Digitaria* flour is used along with baobab milk to produce mixture of high nutritional value. The composite flour contained more nutrients than the baobab or the *Digitaria* flour alone (Obizoba and Anyinka, 1994).

In appraising local varieties for breeding purposes, the presence or absence of diversity is important for a practical breeding programme. It is paramount for the breeder to be acquainted with the potentials of local materials before embarking on population improvement. The starting point in a breeding programme is the availability of

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Wilson, G. F. (1987). Status of bananas and plantains in West Africa. In: Persley, G. J. and De Langhe, E. A. (Eds.) Proceedings of International Workshop on Banana and Plantain Breeding Strategies, Cairns, Australia, 13-17 October 1986. ACIAR, Cairns, Australia.

germplasm collections in order to exploit their potentials in crop improvement.

Many collections have been made of the landraces of *Digitaria* with little genetic information that can lead to their utilization in breeding programme. The little available being the studies by Morakinyo and Awojobi (1997); Morakinyo and Adelekun (1997); Abdul and Zadva (1997) and Aliero (2000). The objective of this work is to characterize the available collections of these two species and to evaluate their yield potentials.

MATERIALS AND METHODS

Ten accessions of *Digitaria* were collected from the Institute of Agricultural Research Samaru, Zaria. Eight of the accessions were *Digitaria exilis* and two were *D. iburua*. The localities of the collected accessions are shown in Table 1.

Table 1. Localities of the materials studied

Accessions	Local Govt.	State
Digitaria exilis		
White mbulus	Irriwai	Bauchi
Jakashale	Irriwai	Bauchi
Red dapvs	Irriwai	Bauchi
Wandat	Tafawa Balewa	Bauchi
Cibo	Gyel	Bauchi
Wun	Gyel	Bauchi
Tsunshalla	Gyel	Bauchi
Biyama	Ningi	Bauchi
D. iburua		
Red iburua	Ningi	Bauchi
Black iburua	Ningi	Bauchi

Green house study

This was conducted in the Department of Biological Science, University of Ilorin in a completely randomized design with 10 replicate per accession. The plants were raised in plastic buckets, which serves as nursery filled with rich loamy topsoil collected from a farmland. The seedlings were later transplanted from the nursery into the plastic containers measured 10-litre capacity.

Quantitative Vegetative, floral and spikelet characters investigated for the accessions are listed below.

1. Days to flowering.
2. Plant height (cm)
3. Number of nodes per culms (tiller)
4. Number of culms (tillers) per plant
5. Stem length (cm)
6. Leaf length (cm)
7. Leaf width (cm)
8. Internodes length (cm)
9. Number of spike per culms
10. Number of spikelet per spike
11. Length of spike (cm)
12. Length of peduncle (cm)
13. Number of spikelets/culm
14. 100 – grain weight(g)
15. Grain yield (Kgha).

Characters such as number of culm number of nodes, number of spikelets/spikes and the number of spikes per culm were counted on a plant basis. Length of spike, internode length, and peduncle length and plant height were measured using metre rule at maturity and at harvest. The number of days to maturity was determined as days from planting to when inflorescence emerged from the sheath of the flag leaf 100-grain weight was measured using Mettler balance (Model PL 300 while Vernier Calliper was used to measure stem diameter.

Pollen Study

Separate planting was done for pollen study so as to avoid distortion of floral characters. Pollen grains were dusted on a

clean slide, a drop of cotton blue in lactophenol was added and a cover sup placed on it. The slide was viewed under a compound microscope. Deeply stained and perfectly shaped pollen grains were considered fertile. Measurement of pollen grains was done at x400 Magnification. The diameters of 30 pollen grains were obtained using microscopic measurements with calibrated eyepiece graticule converted to micrometres (μm; Singh, 1993).

Field Study

Field study was carried out at the University of Ilorin Biological garden located within the guinea Savanna region of Southern Nigeria (Lat. 08° 26'N, Long 04° 29'E) using ten accessions of *Digitaria*. The experimental design was randomized complete block with five replicates, each block is made up of ten plots, and the total plot number was 59. Cultural practices such as weeding, fertilizer application and good sanitation was given to the experimental field. At maturity, plants were harvested on plot basis and the yield each plot was weighed. The grain yield for each accession was analyzed in grams and later converted to Kgha- based on the plot size used.

Mean and standard deviation were calculated for quantitative vegetative and floral characters. Frequency distribution for '100 - grain weight' and number of spike lets per culm' were determined and graphically represented as histograms.

RESULTS AND DISCUSSION

Germplasm Characterization

The qualitative characters scored for each accession are summarized in Table 2. Growth habit (i.e. straggling or erect) appears useful to separate the two species as all *D. exilis* accessions in this study are stragglers except Tsunshalla whose membership of *D. exilis* is questionable because it bears striking resemblance to *D. iburua* in many respect expect absence of leaf sheath pubescence as in *D. exilis*. This result is consistent with the finding of Olorode and Baquar (1976) that growth habit separate *Hyparrhenia involucrata* collections from *H suplumosa*.

The presence of nodal roots in *D. exilis* supports the straggling habit while *D. iburua* lacks nodal roots due to its growth habit. This distinct growth habit is separating the two species. Similarly, the two species have distinct spike arrangements. In all, the *D. exilis* accession except Tsunshalla, digitate type of inflorescence is present while *D. iburua* accession and Tsunshalla have racemose type of inflorescence.

Pubescence of the leaf blade and ligule was observed in all the *D. iburua* accessions studied while *D. exilis* were glabrous except accession Tsunshalla that is hairy. Absence of the leaf sheath hair is not enough to identify Tsunshalla as *D. exilis* accession. It is logical to identify it as a variety of *D. iburua* based on the growth habit. The major distinguishing characters between these two intrageneric species are the presence or absence of hairs and arrangement of spike and spikelets as used in grasses generally (Stace, 1965; Shanna, 1967) in addition to the growth habit reported in this study.

Table 2. Qualitative Characters of the Accessions Studied

Accessions Characters	1	2	3	4	5	6	7	8	9	10
Growth habit	Str	Str	Str	Str	Str	Str	Str	Ere	Ere	Ere
Nodal roots	+	+	+	+	+	+	+	-	-	-
Spike arrangement	Dig	Dig	Dig	Dig	Dig	Dig	Dig	Rac	Rac	Rac
Spike drooping or stiff	Dro	Dro	Dro	Dro	Dro	Dro	Dro	Sti	Sti	Sti
Colour of culm	Red, Yel	Red	Red	Red	Red	Red	Red	Red	Red	Red
Colour of ligule	Red, Bro	Red	Red	Red	Red	Red	Red	Red	Red	Red
Colour of leaves	Gre	Gre	Gre	Gre	Gre	Gre	Gre	Gre	Gre	Gre
Colour of spikelets	Bro	Bro	Bro	Bro	Bro	Bro	Bro	Bro	LBr, Bla	Bla
Colour of grains	Bro CWh	Bro	Bro	Bro	Bro	Bro	Bro	Bro	LBr, Bla	Bla
Colour of leaf sheath	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Hairiness of leaf blade	-	-	-	-	-	-	-	+	+	+
Hairiness of liguke	-	-	-	-	-	-	+	+	+	+
Hairiness of spikelets	-	-	-	-	-	-	-	-	-	-
Hairiness of spikes	-	-	-	-	-	-	-	-	-	-
Hairiness of leaf sheath	-	-	-	-	-	-	+	-	+	+
Glume vein	+	+	+	+	+	+	+	+	+	+
Nodal tillering	+	+	+	+	+	+	+	-	-	-
Awn	-	-	-	-	-	-	-	-	-	-
Spicules on glume	-	-	-	-	-	-	-	-	-	-
Spicules on pedicel	-	-	-	-	-	-	-	-	-	-
Nature of rachilla	SFW	SFW	SFW	SFW	SFW	SFW	SFW	GFW	GFW	GFW

LEGEND

1 = Digitaria exilis (white mbulus)
2 = Digitaria exilis (Jakashale)
3 = Digitaria exilis (Red dapys)
4 = Digitaria exilis (Wandat)
5 = Digitaria exilis (Biyama)
6 = Digitaria exilis (Cibo)
7 = Digitaria exilis (Wun)
8 = Digitaria exilis (Tsunshalla)
9 = Digitaria iburua (Red iburua)
10 = Digitaria iburua (Black iburua)

Str = Straggling; Sti = Stiff; Dig = Digitate Rac = Racemose Dro = Drooping; Gre = Green;
+ = Present; - = Absent Red = Red; Bro = Brown; Lbr = Light brown;
Bla = Black Ere = Erect; ChW = Creamy White; Yel = Yellow;
SFW = Stiff, flattened and winged; GFW = Geniculate, flattened and winged.

Germplasm Evaluation

Means and standard deviation for quantitative vegetative characters in 10 *Digitaria* accessions are presented in Table 3. The result indicated variable means amongst the accessions in the attributes studied. Number of nodes culms, plant height and diameter of stem vary noticeably amongst accessions as well as leaf length, and internodes length. The pattern in internode length amongst accessions showed that Red iburua had the length mean value of 36.60 cm and the lowest of 4.40 cm was recorded in White mbulus Similarly plant height ranged from 97.34 cm to 69.28 cm for Red iburua and Red dapys respectively.

Tillering is an important parameter investigated in the vegetative because of its input on yield. Srinivasan and Khanna (1967) opined that tillering is an inherent character in finger millet. This tillering character is also found in Digitaria species. Haque and Mamman (1995) reported that more tillers per plant meant that crop population is higher and attributed low yield in wheat to low tillering. In this study, however, there were no correlation between the tillering (culms) and yield in

Digitaria accessions. Hence, spike number counts much on the yielding abut (Table 4). From the foregoing, it can be deduced that the more the spikes number, the more the spikelets Similarly, spike length does not have much impact on the yield as does the spike number paid spikelets per culm. This result contradict the report of Haque and Mamman (1995) that the longer the ear length, the more the number of spikelets and consequently the grain number per ear in wheat.

The yield in *Digitaria* is comparatively low which makes comparison very difficult with other cereal crops due to its grain size. The result of this investigation showed yield range of 22-322 kgha (Table 4). Low yield has been attributed amongst other factors to low harvest index resulting from poor plant type (Bunting, 1975, Hadley *et al*; 1983) and late maturity. The superiority of a genotype could he attributed to high number of spikelets per culm, spike number and grain weight. The result also, showed that number of days to maturity differs significantly amongst the accessions and the early maturity types bad higher yield than late maturity. Sreedhara-Murthy *et al* (1977) affirmed that maturity differences do occur within the spikelets that adversely affect yield of many crops The report of this investigation agrees with Abdul *and* Zadva (1997) that *Digitaria* accession differs in number of days to maturity, grain size, spike or spikelet number and grains number per spike.

Seed is considered as one of the plastic organs on a plant and has constant characteristics (Harper, 1977). Seed weight is an important feature widely used and can be easily assessed and is a better indicator of yield in *Digitaria* and a powerful tool for delimiting the two species than number of spikelets culm.

The frequency distribution for grain weight and number of spikelets per culm in accessions studied are shown in Figs. 1 and 2, Fig. 1 shows modal classes for grain weight confirming the distinctiveness of *D. exilis* and *D. iburua* with respect to grain weight because all the grain weight classes around the second modal class with high value belong to *D. iburua*, Fig. 2 shows the distribution of spikelets in the accessions, spikelets numbers are high at the extreme right and modal class is at the left.

Pollen Study

The pollen and seed set data are presented in Table 4 Pollen fertility was very high in all the accessions studied ranging between 76.6% in Red dapys and 93.0% in Cibo Similarly seed set was high amongst the accessions studied, but low in Red dapys. The low fertility and seed set recorded in Red dapys suggested abnormal sporogenesis and low male and female fertility. The high pollen fertility and seed set recorded corroborates the report of Morakinyo and Awojobi (1991) who reported pollen fertility range and seed set of 98.25 and 92.85 in *D exilis* accessions indicating a stable breeding system. The highest pollen diameter of 29.33 µm was recorded in Tsunshalla and the lowest of 22.66 µm in Jakashale. All the accessions studied had comparable pollen size visibility as measured by coefficient of variation.

Pollen morphological variations are known to be very specific for a particular taxon and are therefore a good taxonomic tool. Studies on the pollen size in *Digitaria* showed that the pollen grains of the two species are small and medium sub-category that could have immense significance in taxonomy.

Table 3. Means ± Standard deviation for vegetative *characters* in 10 *Digitaria* accessions

Accession	Number of nodes	Number of culm per plant	Plant height (cm)	Stem diameter (cm)	Leaf Length (cm)	Leaf Width (cm)	Internode length (cm)
White mbulus	13.62 ± 1.9	3.57 ± 0.50	75.12 ± 10.61	0.33 ± 0.05	10.98 ± 2.0	0.75 ± 0.11	4.40 ± 0.73
Jakashale	14.03 ± 1.97	3.80 ± 0.49	69.30 ± 8.82	0.30 ± 0.03	9.67 ± 12.5	0.76 ± 0.08	17.0 ± 3.56
Red dapys	14.54 ± 2.50	4.19 ± 0.80	69.28 ± 11.08	0.29 ± 0.04	10.02 ± 1.67	0.75 ± 0.09	17.26 ± 6.28
Wandat	13.14 ± 1.72	3.26 ± 0.76	75.24 ± 7.06	0.33 ± 0.07	8.58 ± 1.56	0.64 ± 0.10	20.85 ± 2.32
Biyama	13.16 ± 2 50	3.33 ± 0.59	75.40 ± 8.67	0.32 ± 0.05	9.19 ± 1.72	0.70 ± 0.11	23.05 ± 5.24
Cibo	7.64 ± 1.15	4.04 ± 0.61	76.14 ± 7.19	0.34 ± 0.08	9.93 ± 1.75	0.54 ± 0.15	32.62 ± 4.54
Wun	6.63 ± 0.58	3.25 ± 0.59	79.90 ± 9.02	0.34 ± 0.05	9.88 ± 2.28	0.74 ± 0.16	22.72 ± 6.28
Tsunshalla	6.63 ± 0.58	9.86 ± 3.60	77.87 ± 7.88	0.38 ± 0.05	31.36 ± 3.61	0.80 ± 0.19	24.7 ± 4.17
Red iburua	6.47 ± 0.79	7.0 ± 2.02	97.34 ± 10.89	0.50 ± 0.09	36.17 ± 5.03	1.37 ± 0.12	36.6 ± 6.22
Black iburua	6.28 ± 1.08	5.14 ± 1.84	72.34 ± 17.9	0.52 ± 0.07	33.89 ± 7.12	1.34 ± 0.18	25.7 ± 8.37
L. S. D. (0.05)	1.76	1.49	10.64	0.07	3.68	0.14	0.95

Table 4. Means ± Standard deviation for floral and spikelets characteristics in 10 *Digitaria* accessions

Accession	Number of spikes per culm	Number of spikelets per spike	Length of spike (cm)	Length of peduncle (cm)	Days to maturity	Number of spikelets per culm	Weight of 100 grains (g)	Grain Yield (kg/ha)
White mbulus	4.15 ± 0.612	129.7 ± 0.50	9.97 ± 1.39	20.19 ± 4.86	74.65 ± 3.35	599.34 ± 129.34	0.0443 ± 0.003	23
Jakashale	3.69 ± 0.55	124.41 ± 34.74	9.11 ± 1.42	17.00 ± 3.56	74.92 ± 5.36	459.00 ± 138.00	0.039 ± 0.004	22
Red dapys	3.54 ± 0.65	95.47 ± 36.69	8.58 ± 1.30	17.26 ± 6.28	81.96 ± 3.95	339.5 ± 154.67	0.048 ± 0.002	47
Wandat	3.96 ± 0.58	115.6 ± 17.24	9.59 ± 1.04	20.85 ± 2.32	63.70 ± 7.34	456.37 ± 87.25	0.045 ± 0.007	219
Biyama	3.88 ± 0.47	90.54 ± 21.38	9.88 ± 1.52	23.05 ± 5.24	60.10 ± 4.56	351.9 ± 83.68	0.044 ± 0.052	244
Cibo	4.72 ± 0.97	106.78 ± 15.90	11.22 ± 1.34	32.62 ± 4.45	39.64 ± 3.75	501.12 ± 113.7	0.046 ± 0.0052	138
Wun	4.00 ± 0.62	93.88 ± 20.10	10.64 ± 1.07	22.72 ± 6.28	59.20 ± 3.84	368.0 ± 74.50	0.050 ± 0.005	133
Tsunshalla	7.95 ± 0.99	95.66 ± 22.48	8.96 ± 1.12	24.7 ± 4.17	47.80 ± 4.55	752.5 ± 157.3	0.080 ± 0.0096	322
Red iburua	10.09 ± 1.62	148.81 ± 32.45	9.84 ± 1.28	36.6 ± 6.22	57.60 ± 3.97	1474.13 ± 297.67	0.089 ± 0.009	248
Black iburua	8.107 ± 1.64	161.02 ± 37.86	10.7 ± 1.53	25.7 ± 8.37	71.57 ± 3.08	13.30 ± 475.9	0.055 ± 0.077	46
L. S. D. (0.05)	0.97	67.18	0.55	5.45	34.86	9.50	0.0076	8.93

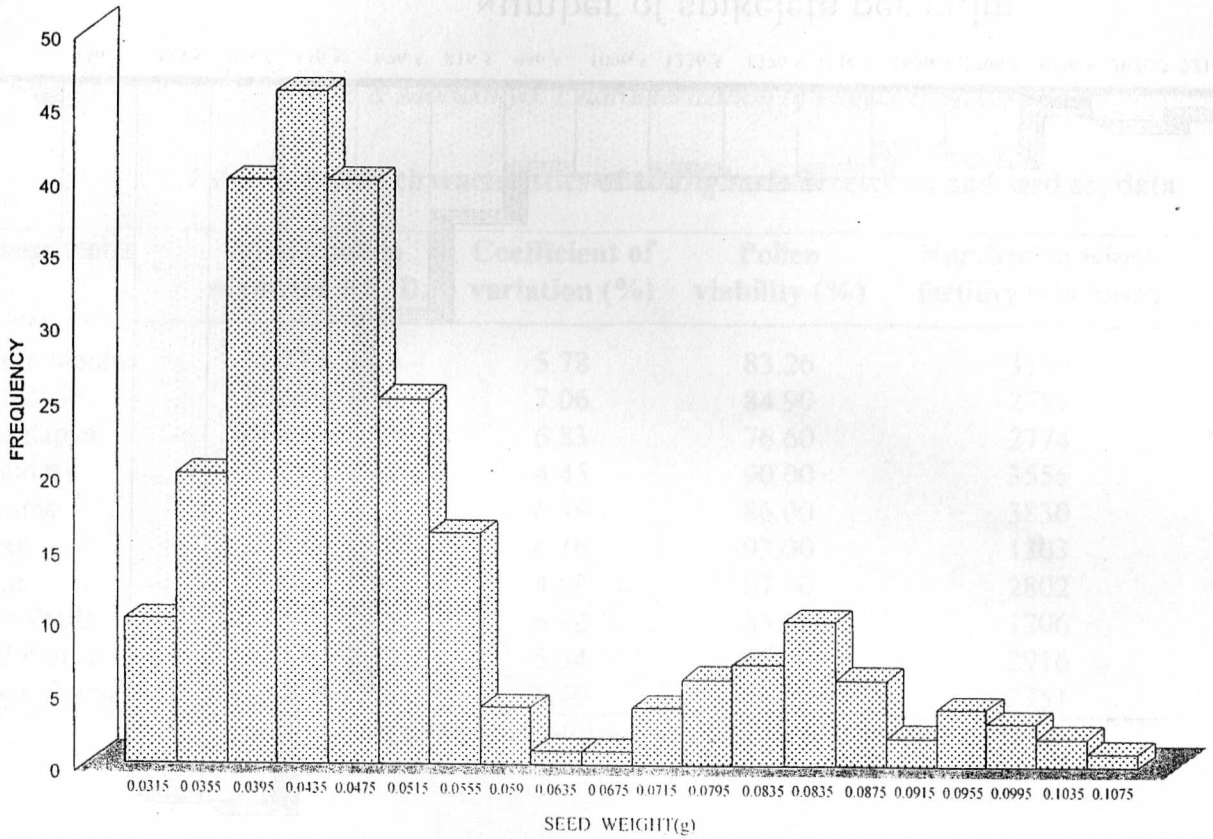

Figure 1. Frequency distribution for seed weight in Digitaria accessions

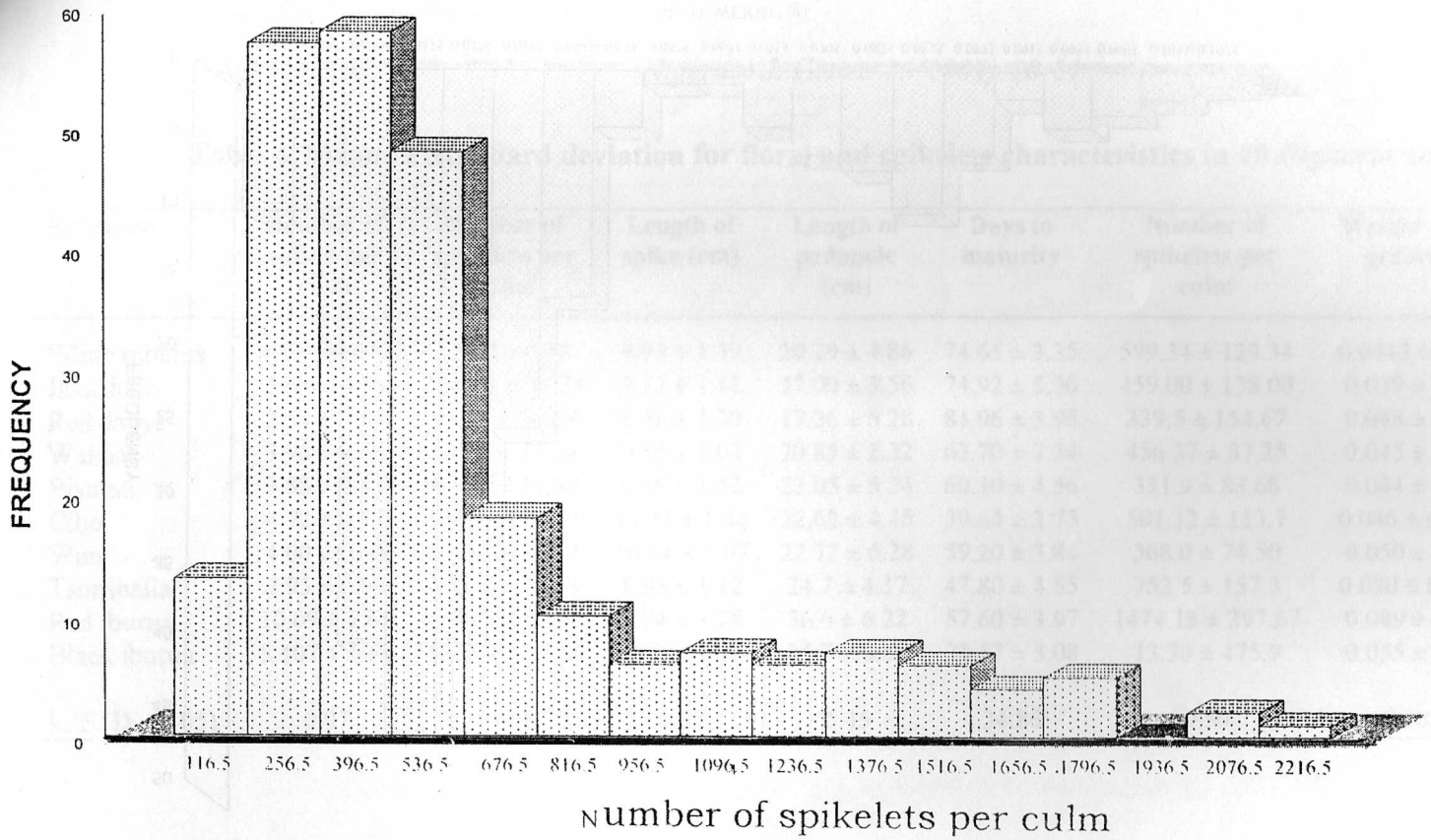

Figure 2. Frequency distribution for number of spikelets per culm in *Digitaria* accessions

Table 5. Pollen characteristics of 10 *Digitaria* accessions and seed set data

Accession	Mean pollen diameter ± S. D.	Coefficient of variation (%)	Pollen viability (%)	Number on which fertility was based	Seed set (%)
White mbulus	24.73 ± 1.43	5.78	83.26	3179	88.87
Jakashale	22.66 ± 1.60	7.06	84.90	2757	84.06
Red dapys	24.13 ± 1.65	6.83	76.60	2774	67.37
Wandat	25.36 ± 1.13	4.45	90.00	3556	nd
Biyama	24.32 ± 1.58	6.49	86.00	3830	69.15
Cibo	25.95 ± 1.60	6.16	93.00	1303	nd
Wun	25.64 ± 1.20	4.68	87.00	2802	nd
Tsunshalla	29.33 ± 2.03	6.92	85.00	1206	nd
Red iburua	28.17 ± 1.42	5.04	85.00	2916	nd
Black iburua	27.65 ± 1.66	6.00	86.40	2751	nd

nd = not determined; Measurement was based on 30 pollen grains

The result of this investigation revealed that the two species overlaps in both qualitative and quantitative characters. These overlaps suggest the level of relatedness of the species and thus the problem of delimiting the species as reported by Henrard (1950) and Kok *et al* (1989).

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