Natural Fertility and Chromosome Numbers in Several Strains of Star Grasses

By

B. N. Okigbo
*Department of Plant/Soil Science,
University of Nigeria, Nsukka*

and

H. R. Chedda
*Department of Agriculture,
University of Ibadan, Ibadan*

ABSTRACT

A survey of fertility in local and introduced strains of star grasses was carried out in several locations during a period of 5 years. Data collected indicated that fertility varied from one location to another and among strains. Cytological data on the chromosome numbers and meiotic behaviour were not correlated with the low fertility. Work on star grass improvement in Kenya and the United States is reviewed and suggestions made as to direction of work to be followed in Nigeria.

INTRODUCTION

Giant star grass, *Cynodon dactylon* (L.) Pers., as other members of the genus is a stoloniferous, perennial grass that has proved to be a highly nutritive permanent pasture grass in many tropical and subtropical areas. It is usually propagated vegetatively with stem cuttings or splits. *C. dactylon* is a highly variable species and contains diploid (2n = 18) and tetraploid forms (2n = 36) (Bogdan and Edwards 1951, and Burton 1964). Seed-set in many strains has been observed to be very poor either due to insufficient quantities of seed per inflorescence or as a result of caryopsis not being formed (Bogdan 1959). Bogdan attributed this to unexplained environmental conditions. Recently, Burton (1964) reported self-infertility to be common in strains of *C. dactylon* and other species of *Cynodon*. The species is known to be normally cross-fertilized or xenogamous (Burton 1947).

C. dactylon (*C. plectostachyus Schum*) has been found very promising as a permanent pasture grass in Nigeria and it was to enhance its use as such that a programme for the production of seed-propagated strains was started at the University of Ibadan in 1960. Early attempts were then made to measure the fertility of strains of *C. dactylon* in this country and to find means of breaking dormancy in both locally collected and introduced strains (Okigbo, 1962). The studies reported here constitute a continuation of the earlier studies. They are directed towards determining the best locality and strain for seed production and developing methods for improvement in this grass.

MATERIALS AND METHODS

Inflorescences of *C. dactylon* that has been established for many years in several agricultural stations in Western Nigeria were collected and the percentage of fertile florets per head was determined. Collections were made from Agege, Ibadan, Fashola, and Shaki in 1960, and 1962. Introductions of several strains (medium, fine and giant) were made from East Africa and established at the University of Ibadan farm and later at Nsukka. Observations on fertility were extended to these in 1964.

Inflorescences of several strains that produced heads were collected and fixed in Carnoy's solution. They were preserved under refrigeration. Microsporocytes were stained in acetocarmine and observations made on the chromosome numbers and meiotic behaviour. The results are presented below.

RESULTS AND DISCUSSION

Natural fertility in giant star-grass was found to vary from one location to another, the highest percentage seed set of 26.5% in Western Nigeria was observed at Agege in 1960 in local strain samples (Table 1), and later still up to 84% seed-set was observed with a recently introduced strain at the University of Ibadan farm in 1962 (Table 3).

The high fertility observed at Agege was contrary to expectations since according to Bogdan (1959), *C. plectostachyus* usually does not produce seed in high rainfall areas. It was observed that flowering or heading in giant star grass did not occur often in open pasture where there is good vegetative growth. Most of the inflorescence heads were found along roadsides or poultry runs where vegetative growth was kept down by trampling or feeding by poultry respectively (Table 2). Only at Fashola, where the open pasture had low vegetative growth due to grazing, was an appreciable number of heads collected. Burton (1936) also observed that flowering occurred when Bermuda grass was mowed low and Bogdan (1949) had noted that intense grazing

Table 1. Natural fertility in giant star grass (*Cynodon dactylon*) in five locations in the Western Nigeria in November 1960.

Class intervals (% Fertility)	Frequencies				
	Agege	*Univ. of Ibadan Farm*	*Moor Plantation*	*Fashola*	*Shaki*
0 — 2.0	21	17	21	24	21
2.1 — 4.1	5	8	11	12	2
4.2 — 6.2	10	9	2	7	3
6.3 — 8.3	3	7	2	2	4
8.4 — 10.4	0	6	5	5	[illegible]
10.5 — 12.5	2	0	5	1	[illegible]
12.6 — 14.6	2	1	1	5	[illegible]
14.7 — 16.7	1	0	1	1	[illegible]
16.8 — 18.8	2	1	1	0	0
18.9 — 20.9	1	0	0	0	[illegible]
21.0 — 23.0	1	0	1	0	[illegible]
23.1 — 25.1	1	1	0	0	0
25.1 — 27.2	1	0	0	0	0
Means	6.08	4.65	5.74	3.35	2.40
Confidence Limits of Means	±1.90	±1.26	±1.48	±0.45	±0.88
Range	0–26.5	0–24.0	0–21.8	0–15.2	0–7.5
Standard Dev.	6.67	4.43	5.22	1.60	5.58

Table 2. Natural fertility in giant star grass (*Cynodon dactylon*) at different locations in the Western Nigeria in February 1962.

Class Intervals	Frequencies at various locations				
	Agege	*Univ. of Ibadan Farm*		*Fashola*	
(% Fertility)	*Roadside*	*Roadside*	*Poultry run*	*Roadside*	*Open Pasture*
0 — 2.0	96	60	137	118	81
2.1 — 4.1	11	14	1	35	7
4.2 — 6.2	5	7	0	14	1
6.3 — 8.3	0	12	0	4	0
8.4 — 10.4	0	3	0	3	0
10.5 — 12.5	0	1	0	1	0
12.6 — 14.6	0	3	0	1	0
14.7 — 16.7	0	0	0	1	0
16.8 — 18.8	0	0	0	0	0
18.9 — 20.9	0	1	0	0	0
21.0 — 23.0	0	1	0	0	0
23.1 — 25.1	0	0	0	0	0
25.2 — 27.2	0	1	0	0	0
Totals	112	103	138	177	89
Means	1.39	3.86	1.02	2.24	1.21
Confidence Limits (95%)	±0.61	±0.89	±0.03	±0.35	±0.19
Standard Error	0.31	0.45	0.02	0.18	0.10
Range	0–5.7	0–27.2	0–3.7	0–15.2	0–4.6

stimulated flowering. Not only does the intensity of flowering vary with grazing but it also varied with strain (Table 4). Some strains such as (IB.8) produced many more flowers than others (IB.2). As observed with flowering, percentage fertility was found to vary from one location to another (Table 3). The range of fertility or seed production of K54301 at Ibadan was about three times greater than at Nsukka.

Comparision of data in Tables 1 and 2 supports Bogdan's (1949) observations that variations is also pronounced from year to year. While it is true that the species is xenogamous and contains self-incompatible lines, it is difficult to explain why heading and seed production were occasionally observed in the early clonal material which was planted in many agricultural stations in different parts of Nigeria.

Table 3. Natural fertility in five strains of star grass at two locations, University of Ibadan Farm (February 1962) and Nsukka (November — December 1964).

Class Intervals	*Frequencies*					
	Ibadan			*Nsukka*		
(% *Fertility*)	51424	51405	54301	*MP Local*	54289	54301
0 — 5	24	42	34	47	49	45
6 — 11	3	5	8	2	1	4
12 — 17	2	1	9	1	2	0
18 — 23	1	0	2	0	2	0
24 — 29	1	0	6	0	0	1
30 — 35	0	0	0	0	0	0
36 — 41	0	0	0	0	1	0
42 — 47	1	0	2	0	0	0
48 — 53	0	0	2	0	0	0
54 — 59	0	0	1	0	1	0
60 — 65	2	0	0	0	0	0
66 — 71	0	0	1	0	0	0
72 — 77	0	0	0	0	0	0
78 — 83	0	0	0	0	0	0
84 — 89	1	0	0	0	0	0
Totals	35	48	71	50	56	50
Means	11.92	3.37	12.33	2.98	5.28	3.46
Confidence Limits (95%)	±6.81	±2.26	±4.28	±0.59	±2.48	±1.05
Standard Error	3.35	1.13	2.15	0.29	1.24	0.52
Range	0–84.0	0–15.3	0–70.5	0–12.5	0–58.1	0–26.7

Table 4. Preliminary observations on natural fertility and number of inflorescences produced per unit area (54 sq. ft) in different strains of star grass at University of Ibadan, 1964-1965.

Acc. No.	*Origin*	*Percent fertility*	*No. of Inflorescences per plot (54 sq. ft.)*
Ib. — 1	Local star grass	13.0	31.25
Ib. — 2	S. Rhodesia G. 191 Mucuga	0	7.50
Ib. — 3	S. Rhodesia G. 330 Tarime	81.0	52.50
Ib. — 4	S. Rhodesia G. 185 Salisbury	3.0	66.75
Ib. — 5	S. Africa	6.0	36.50
Ib. — 7	S. Rhodesia G. 196	0	30.50
Ib. — 8	S. Rhodesia G. 345 Lake Manyara	7.5	264.50
Ib. — 10	Uganda K 54301	29.5	53.50
Ib. — 11	Kenya K 51424	5.5	70.00
Ib. — 13	Uganda K 54289	45.0	40.50

It is quite obvious that the optimum environmental conditions necessary for flowering in giant star grass are still not clearly defined. As observed by Burton (1963) relative humidity, temperature and light have pronounced effects on anthesis in Bermuda grass. In Nigeria most of the flowers appear from November to February indicating that it may either be a short-day plant or that low atmospheric humidity stimulated flowering. Heading has also been observed in many strains at other times during the year.

Data on chromosome numbers in several introduced and local strains indicate that with exception of one (K 51424 i.e. IB. 11) all other strains examined were diploids (Table 5). Meiotic behaviour was not found to be correlated with fertility since no pronounced irregular chromosome associations were observed. This further supported the fact that apart from self-sterility, environment has a considerable effect on fertility, and that more studies on the meiotic behaviour in relation to flowering are needed.

Examination of a large number of florets of giant star grass, has led to the conclusion that no *C. plectostachyus* as described by Bogdan at present is widely grown in the country. According to Bogdan and Edwards (1951) *C. plectostachyus* is Naivasha star grass which usually has the inflorescence in clusters at the top of the stem; the spikes are clustered in whorls with a distinct central axis and the glumes, especially the upper longer glume, only a quarter of the length of the floret. All the strains of *C. dactylon* (which is much more variable than *C. plectostachyus*) have been observed in this country to have upper glumes $\frac{1}{2}$ — $\frac{3}{4}$ the length of the floret. The

Table 5. Chromosome numbers of strains of star grass and their behaviour during meiosis.

	Strain					
	K 53672	*K* 51424	*K* 51405	*K* 54289	*K* 54301	*Local*
Chromosome number	2n = 18	2n = 36	2n = 18	2n = 18	2n = 18	2n = 18
Meiotic behaviour	Fairly regular*	Irregular**	Regular	Regular	Regular	Regular

* Meiotic behaviour regular but occasionally irregular associations were observed. Out of 130 cells studied at metaphase 1, two had one quadrivalent and one with a trivalent.

** Stickness of chromosomes and evidence of fragmentation were observed during metaphase. Associations observed in metaphase I included univalents, bivalents, trivalents and quadrivalents some micronuclei were observed at telophase I and II.

cytological data do not help in the solution of this problem since *C. plectostachyus* is diploid (2n = 18) and *C. dactylon* has diploid and tetraploid forms. According to Meredith (1956), cited in Burton (1964), many strains of *C. dactylon* were previously designated as *C. plectostachyus.*

However, whatever may be the taxonomic problems, it is strongly felt that the objective of producing highly fertile or seed producing types, while tenable, should be of less priority. It is more important to develop a high forage yielding type or types which need not be highly fertile since strains of *C. dactylon* are very easily propagated vegetatively. This method has been mechanized in Georgia, U.S.A., where up to 6 million acres of coastal Bermuda grass are grown (Burton 1964). Vegetatively propagated strains will maintain their uniformity and genotypes more than fertile sexually-propagated forms. Sexually-propagated strains may in future generations segregate into lower yielding and perhaps less adapted off-types. Moreover, because of the dormancy exhibited by seeds of star grasses, production of high yielding sexually propagated strains will also involve breeding for lack of dormancy. Breeding for seed production can also be carried on along the lines suggested by Burton (1964). This involves the use of fields of alternate rows of two self-sterile and cross-fertile clones. Method of isolation of superior genotypes has also been stipulated by Burton and these could considerably help the breeding programme in this country.

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