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Morphological Variability of Pods of Four *Faidherbia albida* Provenances in Senegal

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Abstract

Pods of four Faidherbia albida *provenances from Senegal, each with 20-30 progenies, were analyzed for morphological variability. Pod traits (size and form) were measured and interpreted using analysis of variance, multivariate analysis, principal component analysis, factorial analysis of correspondences, and discriminant factor analysis. Pod dimensions exhibited the greatest morphological variability among the traits measured. Intra-provenance diversity was generally significant, so characterization of geographic origins was difficult. Nevertheless, morphological characteristics of the Bode pods contrasted significantly with those of Kagnobon. The Ovadiour pods were significantly different from the other provenances.*

Introduction

Over the last decade, management of tree genetic resources in Senegal has diminished. A number of recent projects have begun the task of conserving, protecting, and improving these resources (FAO 1980). ***Faidherbia albida,*** due to its value in Senegalese agriculture, was one of the priority species chosen for the program (FAO 1980; Louppe 1989). Diverse studies have since been carried out by international organizations throughout the range of this species. The Direction des recherches sur les productions forestières (DRPF)/Institut sénégalais de recherches agricoles (ISRA) has implemented a program to collect and evaluate genetic resources of ***F. albida*** in Senegal.

This study focused on the biometry of pods. Prior work has shown significant variability in pod form and size of different acacia species as well as of ***F. albida*** (Nongonierma 1977).

Materials and Methods

In 1990, 7 provenances of ***F. albia'a*** from northern to southem Senegal were collected. Seeds and pods were used from the following four provenances by separate progenies: the Merina Dakar provenance from northern Senegal (28 progenies); the Ovadiour provenance from the Groundnut Basin (30 progenies); the Kagnobon provenance from Casamance (20 progenies); and the Bode provenance from Casamance (22 progenies). One hundred progenies in total and ten pods per progeny were studied.

Nine traits were measured and four indices were calculated from these (Table 1). Data were interpreted using analysis of variance, principal components and correspondence analysis, and discriminant factor analysis.

Results

Pod size for all the provenances was extremely variable. This was due to large differences in outside pod length (112-270 mm) inside pod length (44-112 mm), distance between pod tips (12-71 mm), pod width (17-67 mm), and pod mass (292-989 mg). Pods contained 7-23 seeds. Among the important indices calculated, the spiraling index ranged from 0.17-0.90 with an average: of 0.53, the surface area index from

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Chevalier, M.H., Sogna, M., Sarr, A.S., and Danthu, P. 1992. Morphological variability of *pods* of four *Faidherbia albida* provenances in Senegal. Pages 67-70 *in Faidherbia albida* in the West African semi-arid tropics: proceedings of a workshop, 22-26 Apr 1991. Niiy, Niger (Vandenbeldt, RJ., ed.). Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics; and Nairobi, Kenya: International Centre for Research in Agmforestry.

Table L Measured traits and derived indices for *F. albida* pods, Dakar, Senegal, 1991.

Parameter		Abbreviatian
Traits		
Pod mass (mg)		PMS
Outside length (dorsal cleft) (mm)		LDC
Inside length (sutura1 cleft) (mm)		LSC
Length between pod tips (mm)		LEX
Pod width (mm)		PWD
Number of seeds per pod		GPP
Thickness[1]		PTH
Number of angles		NBA
Form[2]		FOR
Indices		
Mean length (mm)	(LDC + LSC) + 2	LOMO
Surface index (mm*)	LOMO + PWD	SUR:F
Spiraling index	LEX +LSC	SPIR
Dcnsity index	LOMO + PMS	PDEIN
Form index	PWD + LOMO	FORM

1. Thickness indices are: 1 = thin; 2 = average; 3 = fleshy.
2. Angle indices are: I = sickle-shaped; 2 = wavy, straight; 3 = spiraled; 4 = tightly spiraled.

1613-9502 mm* and the ratio of width to average length from 0.13-0.54.

Analysis of variance done showed a significant provenance effect for all the variables with the exception of density index and number of angles (Tables 2 and 3). Differences between provenances were highly significant for length between pod tips, pod width, number of seeds per pod, and surface area index. Certain variables characterize each provenance. For example, the Ovadiour provenance had the largest and straightest pods among the provenances studied as well as the fewest number of seeds per pod.

In order to determine correlations between variables, multivariate analyses were carried out using correlation matrices of all the variables. A first analysis was done on the traits measured; the second was done on the calculated indices.

Principal Components and Correspondence Analysis

Principal components analysis is a descriptive statistical method which is often used to examine the inter-

Table 2. Means, standard errors, and CV for seven measured *F. albida* pod characters, Dakar, Senegal, 1991.

	Pod characters						
Provenance	PMS' (mg)	LDC (mm)	LSC (mm)	LEX (mm)	PWD (mm)	GPP	PTH
Kagnobon							
Mean	664	179	73.3	42.7	26.2	2.3	18.6
SE (σ)	167	40	15.4	8.0	5.5	1.0	2.4
CV (%)	26	22	21	19	21	44	13
Ovadiour							
Mean	545	172	74.4	25.3	46.9	2.0	12.6
SE (σ)	102	12	11.9	2.6	12.0	0.9	3.6
CV (%)	19	7	16	10	26	43	28
Bode							
Mean	489	154	61.0	33.7	24.4	1.6	15.3
SE (σ)	121	29	12.5	13	2.6	0.7	3.0
CV (%)	25	19	21	39	11	41	20
Merina							
Mean	507	157	67.9	44.4	30.2	2.0	17.5
SE (σ)	102	18	10.3	7.8	4.9	0.7	2.9
CV (%)	20	11	15	18	16	36	17
Total							
Mean	542	165	69.4	36.0	33.1	2.0	15.8
SE (σ)	134	27	13.5	11.6	12.0	0.8	3.9
CV (%)	25	16	19	32	36	43	25

1. See Table 1 for abbreviation codes.

Table 3. Means, standard errors, and CV for 5 calculated *Faidherbia albida* pod characters, Dakar, Senegal, 1991.

Provenance	LOMO[1] (mm)	SURF (mm^2)	SPIR	PDEN	FORM
	Pod characters				
Kagnobon					
Mean	126	3326	0.61	0.20	0.22
SE (σ)	27	1005	0.15	0.04	0.05
CV (%)	22	30	25	21	23
Ovadiour					
Mean	123	5832	0.35	0.23	0.38
SE (σ)	10	1754	0.07	0.04	0.09
CV (%)	8	30	19	16	23
Bode					
Mean	107	2613	0.56	0.23	0.23
SE (σ)	19	543	0.19	0.05	0.05
CV (%)	18	21	33	21	20
Mer ina					
Mean	113	3395	0.66	0.23	0.23
SE (σ)	12	641	0.10	0.05	0.05
CV (%)	11	19	16	20	20
Total					
Mean	117	3941	0.53	0.22	0.28
SE (σ)	19	1710	0.18	0.04	0.09
CV (%)	16	43	34	20	32

1. See Table 1 for abbreviation codes.

relationships among several variables. The first principal component defines a new variable that explains as much as possible of the variability in the original data. The second principal component is made to be independent of the first and in such a way that it explains as much as possible of the variability that remains. Often the first two components explain a large proportion of the total variability and the data are then usually displayed in a two dimensional plot.

In this study a principal component analysis was conducted on both the traits measured and on the derived indices. The first two axes on the measured traits explained 62.1% of the variation. A display of the data showed that the progenies of Ovadiour could be distinguished from the remaining progenies. A distinguishable contrast also existed between the Bode and Kagnobon progenies. The results from an analysis of the derived variables did not give results that were as clear as with the original variables.

Correspondence analysis was also performed, since this method permits use of the qualitative as well and the quantitative variables. The latter are transformed into classes. This analysis yielded results that were identical to those of the principal components. The quantitative variables were used in the first component. The qualitative variables were used in the second component and did not help in separating the different groups of data.

Discriminant Factorial Analysis

In order to determine the relationship of progenies to their provenances of origin and to test the provenance effect determined by the analyses of variances, a discriminant factorial analysis was done on the traits measured, Only 71% of the progenies were definitely classed in their provenance of origin (Table 4).

Table 4. Classification of progenies into provenances by the discriminant factorial analysis performed on measured traits.

Provenance of origin	Allocated provenance				Correctly classified (%)
	Kagnobon	Ovadiour	Bode	Merina	
Kagnobon	15[1]	0	3	2	75.0[2]
Ovadiour	3	22	5	0	73.3
Bode	2	0	13	7	59.1
Merina	3	0	4	21	75.0

1. Values are numbers of progeny classified in each group, e.g., in the first row of data, 15 Kagnobon progenies were correctly classified in the analysis. Five were incorrectly classified.
2. Percentage of progeny correctly classified in its provenance of origin.

Among the provenances, Bode was the most heterogeneous since 41% of its progeny were classed as Kagnobon and Merina. None of the progenies of Bode, Kagnobon or Merina resembled those of Ovadiour. Ovadiour progenies exhibited specific traits in terms of pod width, length between extremities, pod mass, and number of seeds (Table 2).

Discussion

The great variability in *F. albida* pod morphology shown by this study confirmed results of a study by Nongonierma (1977).

The following traits revealed the greatest diversity of *F. albida* pods collected throughout the Senegalese range of the species: inside and outside pod length between pod tips; pod width; pod mass, and number of seeds per pod. The different form indices (qualitative or calculated variables) and number of angles, provided little benefit to the analysis. In any case, it was very difficult, at the time of measuring, to class the often variable and complex forms of the observed pods.

Intra- and interprovenance variability were of the same order; therefore, it was very difficult to characterize provenances according to their geographic origin. Nevertheless, pod size of the Bode provenance contrasted with that of the Kagnobon provenance. Pods of the Ovadiour provenance were characteristically stubby. To verify if this particular trait of the Ovadiour provenance is unique to its location, three other provenances in the same region will be studied. Also, pods from provenances located at the northern and southem extremes of the Senegalese range of *F. albida* will be analyzed. Finally, the comparison of morphological variability and that obtained from enzymatic markers of the same origin will permit a more complete evaluation of genetic resources of *F. albida* in Senegal.

Acknowledgment. We thank the Laboratoire de génétique et amélioration des plantes, ORSTOM (Dakar) where we performed the statistical analyses.

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