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ANAIS / PROCEEDINGS



Biodiversidade e Produção Sustentável de Alimentos e Fibras nos Cerrados

*Biodiversity and Sustainable Production of Food and Fibers
in the Tropical Savannas*

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FRUIT, SEED PRODUCTION AND SIZE STRUCTURE IN SOME EVERGREEN TREE SPECIES OF THE VENEZUELAN SAVANNAS

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ABSTRACT

A study of the fruit and seed production was undertaken for three woody savanna species: *Byrsonima crassifolia*, *Palicourea rigida* and *Bowdichia virgilioides*. Mean fruit production per tree was greater in *B. crassifolia* with low incidence of predispersal predation, followed by *B. virgilioides* with a high proportion of predated seeds and finally, *P. rigida* with comparatively low incidence of seed predation. Our

results indicate that the studied species produce a great quantity of viable propagules and that although annual seedling recruitment is low, sexual reproduction may play an important role in the establishment of their populations. Resprouting after fire is playing a major role in plant growth and survival.

Additional index words: Savanna trees, reproductive strategies, fruit production, fire, Venezuela.

INTRODUCTION

The Neotropical savannas constitute a distinctive vegetation characterized by the coexistence of two contrasting life forms: grasses and trees. (Sarmiento, 1983).

Two types of woody elements in savannas are represented by the evergreen sclerophyllous trees which grow isolated and whose increasing density gives the character of closed savanna or woodland, and the deciduous trees that generally grow forming groups or islands of dry forests (Sarmiento 1990).

Although there exists an extensive literature on several aspects of the structure and the functioning of tropical savannas around the world (Frost *et al.*, 1986) and particularly in Venezuela (Acevedo & Silva, 1986), little is known regarding the dynamics of regeneration and sexual reproduction of the evergreen woody species.

This paper reports the results of fruit and seed production and its relations to tree size, as part of a broader study on the population biology of evergreen tree species of the Venezuelan savannas.

MATERIAL AND METHODS

Study Site

The study area is a typical seasonal savanna located on

the Andean piedmont hills of Barinas State (8° 38' N - 70° 12' W). The mean annual temperature is 27° C, the mean annual rainfall 1,500 mm., markedly seasonal. Climatically, this area belongs to the Llanos Region of Venezuela (Monasterio, 1970).

The great part of these savannas are characterized by the abundance of woody elements, the very extensive human use and the occurrence of fires almost every year (Silva & Sarmiento, 1976).

Species selection

Three species of evergreen trees with similarities in their general ecology and different morphological characteristics in relation to their fruits and hence their dispersal syndromes, were selected. These species are: *Byrsonima crassifolia* (L.) HBK (Malpighiaceae), *Palicourea rigida* HBK (Rubiaceae), and *Bowdichia virgilioides* HBK (Leguminosae). The processes of renewal of their foliage and blooming occur during the dry season. *B. crassifolia* is a small tree, usually 4-6 m in height, with drupaceous fruits, that presents a yellow color when ripe, 5-8 mm diameter. *P. rigida* is a small tree (up to 3 m in height), with small black globular fruits 5 mm long. *B. virgilioides* is a small tree, 4-8 m in height, with a legume fruit, 4-7.5 cm long, 10-15 mm wide, flat, orange, and light.

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Vegetation sampling

Vegetation census in 1 ha plot was undertaken to determine the density, phenological characteristics and plant stage (seedlings, sprouts, adults) of each species studied. All sampling was carried out during the dry season of 1993, 1994 and 1995. Four 2500 m² plots, subdivided in 8 sectors of 12,5 x 12,5 m were sampled in the study area. The total height, stem diameter at the base and at the first ramification were registered for each species.

Fruit and seed production

To estimate fruit and seed production, individuals of all size range were sampled. All fruits were counted in 10 and 30 individuals of *B. virgilioides* and *P. rigida* respectively. For 30 individuals of *B. crassifolia*, all the green fruits were counted in small and medium size stems (< 12.7 cm basal stem diameter), while in the big ones (> 12.7 cm basal stem diameter) partial countings of green fruits were made by random sampling of branches, after a previous counting of the number of first, second and third order branches. A sample of fruits of each species was randomly collected from up to ten of the tagged trees and the enclosed seeds were classified as intact, aborted (empty/shrivelled) or predated (visible exit hole in seed coat). Seed production in each survey year was calculated from the estimated number of fruits per tree multiplied by the mean number of intact seeds per fruit. Besides, for a minimum of 10 individuals per species, it was determined the number of flowers per inflorescence and fruits per infructescence by countings in a maximum of 100 inflorescence and 100 infructescence per species respectively.

RESULTS

Density and size distribution

The census results (Table 1) indicate a high density of stems (*B. crassifolia*, 187 ind/ha; *B. virgilioides*, 101 ind/ha; *P. rigida*, 358 ind/ha). Also there is a relative low density of seedlings (mean 17% for the three species), and a high proportion (mean 22% for the three species) of sprouts in the lower size range.

TABLE 1 - Density and plant stage of the studied species in 1 ha plot.

Species	<i>B. crassifolia</i>	<i>B. virgilioides</i>	<i>P. rigida</i>
No. ind/ha	187	101	358
% seedlings	13	18	21
% sprouts	36	18	13
% adults	51	64	65

The frequency distributions of stem diameter shows that the majority of the individuals belong to smaller size classes (mean 53 % for the three species between 0-3.18 cm basal stem diameter) (Figure 1).

Fruit and seed production

Blooming starts when plants reach 100 cm height and 3.18 cm basal stem diameter for both *B. crassifolia* and *P. rigida*. There is a tendency of continuous increases of the reproductive activity along with height (Figure 2).

TABLE 2 - Estimated values of the fruit and seed production of the studied species.

Species	<i>B. crassifolia</i>	<i>B. virgilioides</i>	<i>P. rigida</i>
Flowers/inflor.	33.97±3.82	94.80*	249.41±22.32
Fruits/infruit.	22.17±1.54	7.99*	90.36±13.35
% Aborts			
flowers-fruits	34,74	91.57*	63,86
Fruits/ind.	29790±4426	2404,26	1823.63±249.41
Seeds/fruit	2.87±0.03	1.58*	2
Seeds/ind.	85497,3	3798,73	3647,26
% Viable seeds	66.67±6.64	48.89±11.47	81.23±2.73
Viable seeds/ind	57001	1857	2677
% Predated seeds	10.09±2.16	61.36±4.45	18.05±4.24
Viable seeds produced/ha	2.91x10 ⁶	1.19x10 ⁵	1.74x10 ⁵

* Data from Ramírez (1993)

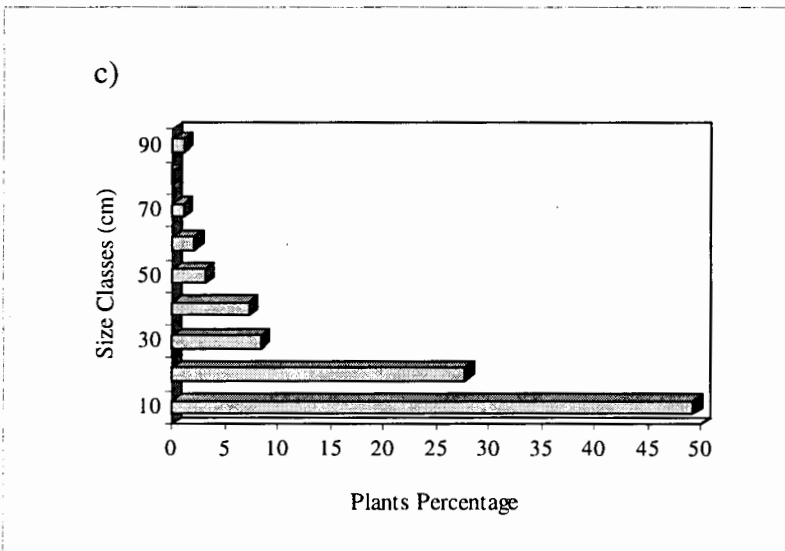
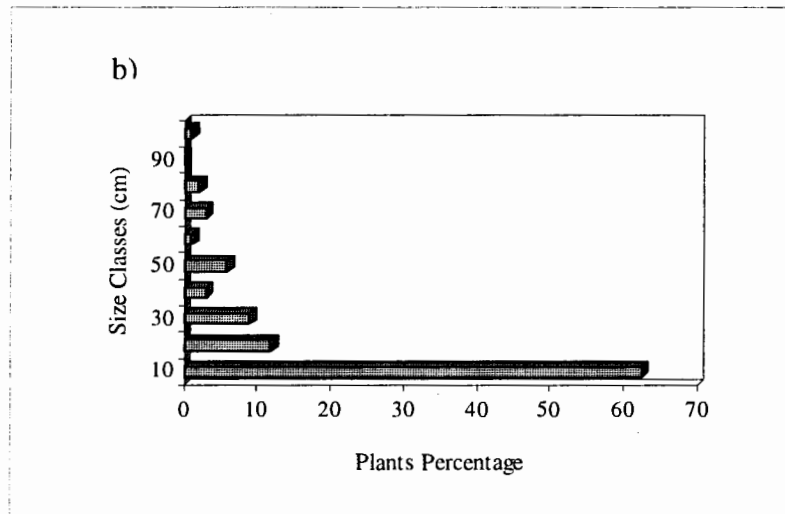
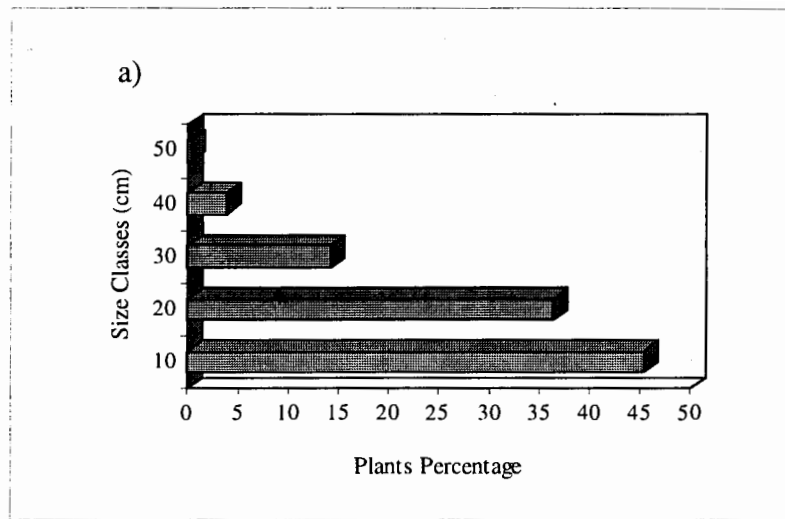


FIG. 1 - Frequency distribution of the basal circumference for a) *P. rigida*, b) *B. virgilioides* and, c) *B. crassifolia*. Data from 1 ha plot in the studied area.

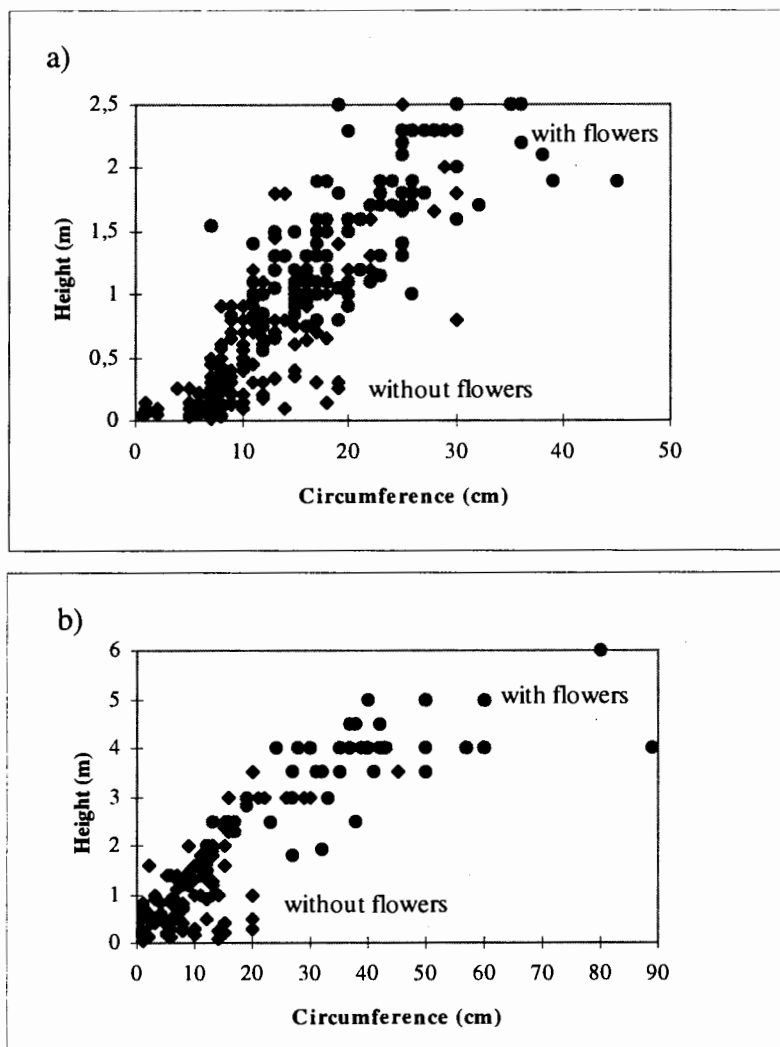


FIG. 2 - Relation between height (m) and basal circumference (cm) for a) *Palicourea rigida* and b) *Byrsonima crassifolia*. Data from 1 ha plot in the studied area.

Although the mean fruit production was highly variable with respect to the stem height and basal diameter, there is a trend of fecundity to increase with tree height (Figure 3).

Mean fruit production per tree was greater in *B. crassifolia* (29790 ± 4426 fruits/ind.), with low incidence of predispersal predation ($10,09 \pm 2,16\%$). *B. virgiliodes* (2404 fruits/ind.) with high proportion of predated seeds ($61,36 \pm 4,45\%$), and finally, *P. rigida* (1824 fruits/ind.) with comparatively low incidence of seed predation ($18,05 \pm 4,24$) (Table 2).

DISCUSSION

The density of *B. crassifolia* and *B. virgiliodes* in our study area is high. It is even higher than the densities reported by San José & Fariñas (1991) for the Calabozo Station after 25 years of fire and grazing exclusion. These differences in

the evergreen woody density seems related to the plant available moisture period (PAM) (Medina & Silva 1980). Average annual rainfall and PAM length in Barinas are 1400 mm, 239 days, and in Calabozo 1239 mm and 222 days (Bailey, 1979, cited in Medina & Silva, 1990).

The population structure of each species was characterized by an inverted "J" size distribution, which indicates that they could be young populations in expansion. However, the majority of the individuals in the smaller classes are sprouts of trees that had been partially destroyed by fire. The results of the trees census suggest that the annual recruitment of new individuals in the populations is low and that resprouting is very important in the dynamics of these populations. Ataroff (1975) reported similar results for both *B. crassifolia* and *C. americana*, with even a higher proportion of sprouts and a relative small density of seedlings.

Changes in trees density in the Calabozo Station (San

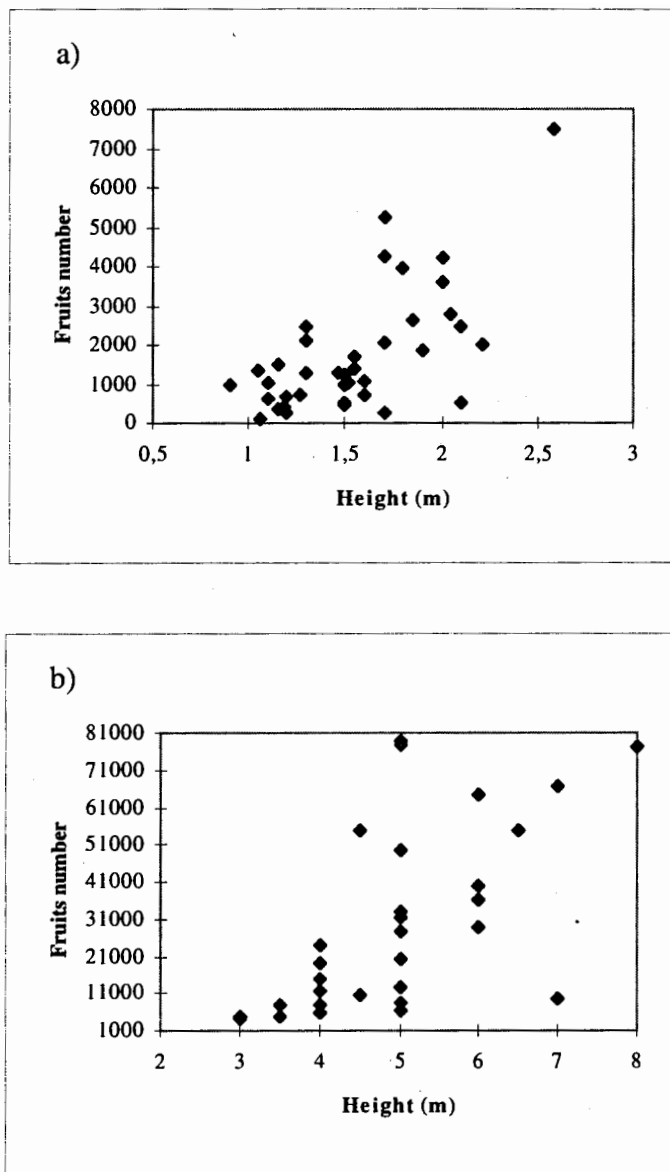


FIG. 3 - Relation between height (m) and fruits number for, a) *Palicourea rigida* (N=38 trees) and b) *Byrsonima crassifolia* (N=30 trees).

José & Fariñas, 1991) suggest that under fire and grazing exclusion, recruitment of evergreen trees is favored. In our study area, under the present regime of management and fire, with fire frequencies of 0.5 to 1 and with little variation in precipitation regime, we expect the woody populations to be in a steady state.

The evergreen savanna trees suffer a high mortality by fire in their first stages, but when they reach a threshold height and development, survival rates increase.

Estimations of the age-size relation in *B. crassifolia* (Ataroff 1975) show that the critical age is approximately between 10 and 35 years and this also coincide with the appreciations made by Menaut (1990) on the woody species

in Lamto savannas. These appreciations about critical height and age are clearly related to the reproductive activity. In our study, the critical height of blooming for both *B. crassifolia* and *P. rigida* is about 100 cm height, what coincides with the fire height in savannas regularly burned.

Our results suggest that at least in *B. crassifolia* there are no limitations in seed formation, provided that more than a half of the flowers are fecundated (65%) and there is a low incidence of predispersal predation (10%). For both *P. rigida* and *B. virgilioides* there could be a major limitation for sexual reproduction once less than a half of flowers are fecundated (36% and 8% respectively) and with a high proportion of predated seeds.

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