Stump regrowth and estimation of reconstituting
Caatinga shrub-tree biomass under forest managementRebrota de cepas e reconstituição da biomassa
arbustiva-arbórea de Caatinga sob manejo florestalTamires Leal de Lima¹, Rinaldo Luiz Caraciolo Ferreira², José Antônio Aleixo da Silva²,
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Resumo

Objetivou-se avaliar a rebrota e reconstituir a biomassa arbustiva-arbórea a partir das cepas em uma área de Caatinga sob manejo florestal em Floresta-PE, Brasil. Dois anos após intervenção em 18 parcelas foram medidas as circunferências e alturas das cepas e dos perfilhos. Foi avaliada a influência do diâmetro e da altura da cepa na brotação das espécies. Em uma área próxima e sem intervenção, foram tomados dados de diâmetro a altura da base e do peito para reconstituição da biomassa explorada. Verificou-se que *Poincianella bracteosa* e *Aspidosperma pyrifolium* emitiram maior número de perfilhos nas cepas com circunferência maior que 30 cm, mas sem influência da altura da cepa. A biomassa média estimada (17186,16 kg ha⁻¹) foi similar a áreas submetidas à intervenção antrópica e a sua reconstituição pode ser uma ferramenta auxiliar na para órgãos ambientais na fiscalização de desmatamento ilegal.

Palavras-chave: corte raso, regeneração natural, semiárido

Abstract

This study aimed to evaluate stump regrowth and estimate the reconstitution of shrub-tree biomass from the stumps in an area of Caatinga under forest management in Floresta-PE, Brazil. The circumferences and heights of the stump and sprouts were measured two years after an intervention on 18 plots. The influence of the stump diameter and its height on the sprouting ability of the species was evaluated. Data was taken in the next area without intervention in order to estimate the diameter at breast height for reconstitution of the exploited biomass. We found that the tillering for *Poincianella bracteosa* and *Aspidosperma pyrifolium* was influenced by the size of the circumference, but not by the stump height. The average estimated biomass (17186.16 kg ha⁻¹) was similar to other areas also subject to human intervention, and its reconstitution can be an auxiliary tool for monitoring illegal deforestation by environmental agencies.

Keywords: Clearcutting, natural regeneration, semiarid.

INTRODUCTION

The exploitation of forest resources especially in the search for fuel material to meet the energy demand of the Brazilian semi-arid region has led to a reduction in the area covered by vegetation due to anthropic action, and consequently of its plant and animal diversity. In this scenario, the Sustainable Forest Management Plan (PMFS) regulated by the State Environmental Bodies emerges as one of the alternatives for rational exploitation of forest resources, since it aims at the continued procurement of forest goods and services, without altering its productive capacity and biological diversity.

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This practice is being adopted in the Caatinga based on the principle that after the beginning of the forest cut, its original stage will be returned within a cut cycle of 15 years or more, according to legislation in several states of Northeast Brazil. However, there is no scientific evidence for this information, since there are already studies that indicate that 15 years of cutting cycle is insufficient to recover the vegetation stock (GARIGLIO et al., 2010).

In addition to causing environmental impacts, the extraction and removal of vegetation may compromise the sustainability of management plans, including the ability to regrow stumps (SCOLFORO et al., 2008) since the strength and resilience of regrowth are influenced by the stage of growth in which the plant is harvested, the cutting height, the levels of nutritional reserves and the effect of the climatic variations during the readaptation time of individuals (TEWARI et al., 2004). Also, these factors may present distinct responses in the species' ability to regrow.

In executing the management plan, there is the need to control action through inspection agencies, seeking to ensure that the areas cleared for cutting are being correctly managed; this means the monitoring of these areas is planned by implementing plots with individuals being identified and labeled with the established level of inclusion. This information will help to quantify, among other issues, the impacts caused by the exploitation, to know the natural regeneration, to assist in the decision-making regarding the forest management (cutting cycle, silvicultural practices, etc.), and to verify the floristic diversity and the survival of the stumps according to the species.

The establishment of permanent plots can also assist inspection agencies in cases of wood being illegally removed, in addition to helping understand the regrowth. This is because a relationship can be obtained with neighboring areas of similar composition and forest structure (ERCANLI et al., 2015; PETER; CONSTANCE, 2010) due to the diameter of the stumps left in the field for elaborating mathematical models to estimate the biomass that was extracted in an acceptable manner, thereby helping the agents to prepare infraction notices.

Direct methods for quantifying forest biomass are less adopted because they are costly and because they have an impact on the vegetation due to the need of tree felling. Therefore, indirect methods that reliably estimate tree biomass are preferred. Statistical models have been developed for this and used to estimate woody biomass left standing and/or from the diameter of the remaining stock (ERCANLI et al., 2015; NASCIMENTO et al., 2010; ÖZÇELİK et al., 2010; SAMPAIO et al., 2010; SILVA; SAMPAIO, 2008; THORPE et al., 2010).

In this context, the objective of this work was to evaluate the ability to regrow stumps after two years of forest harvesting, as well as to indirectly estimate the original biomass reconstitution in a Caatinga area under PMFS in Floresta, Pernambuco, Brazil.

MATERIAL AND METHODS

Characterization of the study area

The study was conducted in an area with Caatinga vegetation located at Fazenda Itapemirim, in the municipality of Floresta, a mesoregion of São Francisco, Pernambuco. According to the Köppen classification, the climate of the region is BSs'h', low dry semi-arid, with a dry period of 9 months, and annual rainfall less than 500 mm concentrated from February to April (ALVARES et al., 2013). The vegetation that occurs in the present study area is savanna-steppe (IBGE, 2012), and the soil of the region is classified as shallow Chromic Luvisols (EMBRAPA, 2006).

Sample structure and data collection

The study area is located inside a field with a surface area of 59.2 hectares, which is part of a PMFS in which the vegetation was submitted to clearcutting in the year 2013. At that time, there was no cutting of *Myracrodruon urundeuva* (Engl.) Fr. All. (Aroeira) or *Schinopsis brasiliensis* Engl. (Braúna), since they were on the official list of Brazilian flora species threatened with extinction (BRASIL, 2008) that was in force during the cut in 2013.

The area was demarcated and georeferenced, with 18 permanent plots being installed with a dimension of 20 m x 20 m each, making a total sample area of 7200 m². The plots were systematically allocated in two rows of nine plots, 20 m apart between rows and plots.

The first survey was carried out two years after the cut (July 2015) with the vegetation in its regrowth and regeneration stage, and all shrub-tree individuals were identified, measured and tagged as dead, remaining or in regrowth. The live stumps were submitted to CAB, cut height and quantification of tillers (budding), in addition to their CAB and total height.

Sprout regrowth analysis

The regrowth capacity of the stumps by species was determined by the rate of stumps that showed tiller emission. To evaluate the influence of the stump CAB and the cut height of the stump on the tiller emission (number of tillers stump⁻¹, mean CAB of the tillers and the average height of the tiller), an analysis of the simple linear correlation between these variables was conducted.

The species with the greatest density of re-growing stumps (*Poincianella bracteosa* and *Aspidosperma pyrifolium*) were submitted to analysis of variance to verify if the circumference variation of the stumps and the height at which the stumps were cut influenced the regrowth (number of tillers). For this, the data were divided into circumference classes (Class I: $1 \leq \text{CAB} < 15\text{cm}$; Class II: $15 \leq \text{CAB} < 30\text{cm}$; Class III: $30 \leq \text{CAB} < 45\text{cm}$ and Class IV: $\text{CAB} \geq 45\text{cm}$) and height (Class I: $2 \leq H < 15\text{cm}$; Class II: $15 \leq H < 30\text{cm}$ and Class III: $H \geq 30\text{cm}$).

The response variable number of tillers for the two considered species had their data transformed by non-normality and variance heterogeneity by the Kolmogorov-Smirnov and Bartlett tests, respectively, both at the 95% confidence level. To comply with the assumptions, the Box and Cox method was used to stabilize the variance by means of a power () estimated by maximum likelihood, assuming a lambda value of 0.16 for the *Poincianella bracteosa* species, and logarithmic transformation for the *Aspidosperma pyrifolium* species due to presenting values of with zero contained within the confidence interval, as described by Box and Cox (1964).

A completely randomized design in factorial arrangement was used for this. The treatments were the combination of height classes (3) and CAB (4) with a different number of repetitions (unbalanced), and with the number of tillers in each class of cut height or circumference class of the stump as the repetitions. The existence of influence on tiller emission of these species in relation to cutting height and/or circumference of the stump was verified by ANOVA, while the average number of tillers in the stump diameter and height classes were compared by the Tukey-Kramer test at a 95% level of confidence (= 0.05).

The PROC MIXED procedure by the LS means test (estimates of adjusted means for unbalanced data) of the SAS statistics system version 9.1 was used for the analysis (SAS, 2004).

Reconstitution of woody biomass

To estimate the woody biomass from the DAB of each individual, it was initially necessary to adjust models to estimate their respective DBH (diameter at 1.30 m of soil height), since vegetation before cutting was not measured (Table 1). Thus, 928 pairs of DAB and DBH data were used from similar vegetation near the cutting site (same PMFS study area). The DBH for the multi-stems individuals was obtained using the mean square diameter.

Table 1. Models tested for estimating the DBH due to the DNS in a Caatinga area, Floresta-PE, Brazil.

Tabela 1. Modelos testados para estimativa de DAP em função do DAB em uma área de Caatinga, Floresta-PE, Brasil.

Number	Equation	Authors
1	$DAP_i = \beta_0 + \beta_1 * DAB_i$	Nascimento et al. (2010)
2	$DAP_i = \beta_1 * DAB_i$	Horn; Keller (1957)
3	$DAP_i = \beta_0 + \beta_1 * DAB_i + \beta_2 * DAB_i^2$	Scolforo et al. (2008)
4	$DAP_i = \beta_0 * DAB_i \beta^2$	Johnson; Weigel (1990)
5	$\ln(DAP_i) = \beta_0 + \beta_1 * \ln(DAB_i) + \beta_2 * (\ln(DAB_i))^2$	Gehring et al. (2008)
6	$DAP_i = \beta_0 + \beta_1 * (DAB_i)^{1/2} * \ln(DAB_i)$	Nascimento et al. (2010)
7	$DAP_i = \beta_0 + \beta_1 * DAB_i * (\ln(DAB_i))^{-1}$	Nascimento et al. (2010)
8	$DAP_i = \beta_0 + \beta_1 * (DAB_i)^{1/2}$	Nascimento et al. (2010)
9	$DAP_i = \{\beta_0 + \beta_1 * [\ln(DAB_i)]^2\}$	Nascimento et al. (2010)
10	$DAP_i = [\beta_0 + \beta_1 * \ln(DAB_i)]^2$	Nascimento et al. (2010)

Where: $\beta_0, \beta_1, \beta_2$ = coefficients; DAP = diameter at breast height; DAB = diameter at base height.

Em que: $\beta_0, \beta_1, \beta_2$ = coeficientes; DAP = diâmetro à altura do peito; DAB = diâmetro à altura da base.

After adjusting the models, a graphical analysis of the residues was performed to verify the existence of bias in the estimates. The adjusted coefficient of determination (R^2_{aj}), standard error of estimate (SYX), the coefficient of variation (CV%) and F value were calculated to identify the model that best fit the data. For the comparison between logarithmic and arithmetic models, the Furnival index (IF) (SILVA; BAILEY, 1991) was used to correct the standard error of the estimate in the original scale of the dependent variable (Equation 1).

$$IF = f'(DBH)^{-1} \exp\left(\frac{n-p}{2n}\right) * S_{YX} \quad (1)$$

Where: $f'(DBH)^{-1}$ = derived from the dependent variable in relation to the DBH of the individuals; n = number of observations; p = number of model parameters; S_{YX} = standard error of the estimate.

The original DBH was estimated from the selected model, based on the DAB of the stumps remaining in the field. The equation of Silva and Sampaio (2008) was used for Caatinga vegetation located about 70 km from the studied area (Equation 2) and validated for the present study by Lima et al. (2017).

$$Biomass = 0.2368 * DBH^{2.2219} \quad (2)$$

Where: DBH = diameter at the height of 1.30 m.

RESULTS AND DISCUSSION

Sprout regrowth capacity

Two years after the forest cutting, 1173 stumps were sampled, corresponding to an absolute density of 1629.2 stumps ha^{-1} , distributed across 16 different species (Table 2). The most frequent species were *Poincianella bracteosa*, *Mimosa tenuiflora*, *Thiloea glaucocarpa*, *Mimosa ophthalmocentra* and *Aspidosperma pyrifolium*, which together represented 84% of the total density observed in the study area. Of these species, only *P. bracteosa* and *A. pyrifolium* presented high regrowth capacity with rates of 94.8% and 79.7%, respectively. In general, 63.4% of the stumps had tiller emission, showing mean values of 5.7 tiller stump $^{-1}$. *A. pyrifolium* was the species with the highest tiller emission (12.7 tillers stump $^{-1}$).

Table 2. Analysis of sprouting in live stumps in a Caatinga area under forest management, Floresta-PE, Brazil.
Tabela 2. Análise do perfilhamento em cepas vivas em uma área de Caatinga sob manejo florestal, Floresta-PE, Brasil.

Nome científico	DA		Live Stumps		%R	Regrowth		
	Total	N	DA			NP	NPméd	DP
<i>Poincianella bracteosa</i> (Tul.) L.P. Queiroz	933,3	637	884,7	94,8	3449	5,4	4,12	
<i>Mimosa tenuiflora</i> (Willd.) Poir.	138,9	5	6,9	5,0	21	4,2	1,92	
<i>Thiloea glaucocarpa</i> (Mart.) Eichl.	106,9	4	5,6	5,2	7	2,8	1,26	
<i>Mimosa ophthalmocentra</i> Mart. ex Benth.	101,4	0,0	0,0	0,0	-	-	-	
<i>Aspidosperma pyrifolium</i> Mart.	88,9	51	70,8	79,7	647	12,7	9,72	
<i>Commiphora leptophloeos</i> (Mart.) J.B. Gillett	58,3	8,0	11,1	19,0	24	3,0	2,20	
<i>Piptadenia stipulacea</i> (Benth.) Ducke	47,2	1,0	1,4	2,9	1	1,0	-	
<i>Manihot carthaginensis</i> subsp. <i>Glaziovii</i> (Müll.Arg.) Allem	41,7	14,0	19,4	46,7	31	2,2	0,97	
<i>Bauhinia cheilanta</i> (Bong.) Steud.	36,1	0,0	0,0	0,0	-	-	-	
<i>Cnidoscolus quercifolius</i> Pohl	29,2	18,0	25,0	85,7	76	4,2	1,83	
<i>Sapium glandulatum</i> (Vell.) Pax	27,8	0,0	0,0	0,0	-	-	-	
<i>Erythrostemon calycina</i> (Benth.) LP Queiroz	6,9	3,0	4,2	60,0	5	1,7	0,58	
<i>Pseudobombax marginatum</i> (St. Hill) Rob	5,6	2,0	2,8	50,0	3	1,5	0,71	
<i>Jatropha mollissima</i> Muell. Arg.	4,2	0,0	0,0	-	-	-	-	
<i>Cnidoscolus pubescens</i> Pohl	1,4	1,0	1,4	-	9	9,0	-	
<i>Croton rhamnifolius</i> H. B. K.	1,4	0,0	0,0	-	-	-	-	
Total Geral	1629,2	744	1033,3	63,4	4273	5,7	5,01	

N = number of sampled stumps; DA = absolute density (stumps ha^{-1}); % R = ability to regrowth stumps; NP = number of sprouts; NPméd = mean number of sprouts stumps $^{-1}$; SD = standard deviation.

N = número de cepas amostradas; DA = densidade absoluta (cepas ha^{-1}); %R = capacidade de rebrota das cepas; NP = número de perfilhos; NPméd = número médio de perfilhos cepa $^{-1}$; DP = desvio padrão.

The association between stump circumference and the number of tillers was confirmed by the Pearson correlation analysis, which showed a positive correlation of 0.545 for all species (Table 3). This means that a larger CAB of the stump increased the number of emitted tillers. There was also a positive correlation between the means of the tiller CAB and mean height of the tiller, indicating that the bigger the tiller CAB, the larger their height. According to Perrando and Corder (2006), the correlation between CAB and the number of tillers can be justified by the presence of basal and adventitious buds resulting from the increase of the peripheral region of the wood, thus aiding regrowth.

Table 3. Pearson correlation for stump circumference at the base (CABC), stump height (HC), the number of sprouts (NP), circumference at the base (CABP) and height of the sprouts (HP) for all species found in a Caatinga area under forest management, Floresta-PE, Brazil.

Tabela 3. Correlação de Pearson para circunferência na base da cepa (CABC), altura de cepa (HC), número de perfilhos (NP), circunferência na base (CABP) e altura dos perfilhos (HP) para todas as espécies encontradas em uma área de Caatinga sob manejo florestal, Floresta-PE, Brazil.

Variables	CABC	HC	NP	CABP	HP
CABC	1,000				
HC	-0,038	1,000			
NP	0,545 *	-0,107	1,000		
CABP	0,358	-0,221	0,247	1,000	
HP	0,350	-0,234	0,325	0,806 *	1,000

* Significant by t test ($p < 0,01$).

* Significativa pelo teste t ($p < 0,01$).

The correlation found between the variables of stump CAB and the number of tillers may also be related to the nutritional reserve in both the stumps and the roots, which may allow for an amount of carbohydrates needed for each stump to regrow. In this sense, Bond and Midgley (2001) emphasized that cut plants store nutrients to survive future disturbances, even reducing their regrowth speed.

From the performed measurements, it was also observed that the height at which the individuals were cut was not standardized, which could have also influenced stump regrowth. However, in this case it is observed that there was no significant correlation (-0.107), which may be associated to the small evaluation period in the present study, as well as the more severe drought, which according to Marengo et al. (2016) has been occurring in the Brazilian Northeast since 2011, and has worsened between 2012 and 2015.

The high correlation observed between the tiller base circumference and tiller height (Table 3) can be justified by the higher resistance to drought by the species that presented live stumps and a higher number of tillers (Table 2), even though there may be faster establishment than seedlings. Thus, regrowth by means of stumps can achieve greater success in growth and survival compared to recruitment from the seed bank (BOND; MIDGLEY, 2001; KY-DEMBELE et al., 2007) and significantly contribute to the recovery of forest canopy and microclimate, playing an essential role in the succession and restoration of dry forest (SHACKLETON, 2001; VIEIRA; SCARIOT, 2006).

It is important to note that distinct behavior in the regrowth capacity between species was observed in the field, which was a response also seen by Bond and Midgley (2001) who reported that plants with similar leaf characteristics might have very divergent growth rates depending on the allocated reserves for regrowth. Paula and Pausas (2006) also stated that basal regrowth depends on stored reserves in the underground biomass, which is generally a deep and well-developed root system.

For Ferreira et al. (2015), *P. bracteosa* has a strategy of slow growth and small adjustments in biomass. This behavior allows a higher efficiency of water use, and consequently a higher capacity of survival and dominance in the Caatinga area *stricto sensu*, as is the case in the present work. On the other hand, other species (including *A. pyrifolium*) may be more dependent on water resources and suffer more negative impacts when these resources become scarce; meaning this can affect regrowth in their stumps.

For the two species of higher density in the study area, it was verified that the variable response of the number of *P. bracteosa* ($Y^{0.16}$) tillers submitted to analysis of variance only showed an influence on the emission of tillers in relation to the stump circumference classes ($\text{Prob.} > F < 0.0001$). Similar behavior was obtained for *A. pyrifolium*, in which the natural logarithm transformation (due to non-normality of data) of the number of tillers ($\ln \text{NPerf}$) also showed a difference in the number

of tillers in relation to the stump circumference classes, and no influence of the stump cut height on the number of tillers (Prob. > F = 0,8232) (Table 4).

Table 4. Analysis of variance for the number of sprouts of *Poincianella bracteosa* and *Aspidosperma pyrifolium* in the stump circumference at the base (CABC) and stump height (HC) classes, Floresta-PE, Brazil.

Tabela 4. Análise de variância para número de perfilhos da *Poincianella bracteosa* e *Aspidosperma pyrifolium* nas classes de circunferência na base da cepa (CABC) e de altura de cepa (HC), Floresta-PE, Brasil.

<i>Poincianella bracteosa</i> (Tul.) L. P. Queiroz					
FV	GL	SQ	QM	F	Pr > F
Model	11	4,3367	0,3942	23,59	<,0001
Class CABC	3	4,1585	1,3862	82,95	<,0001
Class HC	2	0,0434	0,0217	1,30	0,2734
Class HC x Class CABC	6	0,1348	0,0225	1,34	0,2350
Error	625	10,4442	0,0167		
Total	636	14,7810			
<i>Aspidosperma pyrifolium</i> Mart					
FV	GL	SQ	QM	F	Pr > F
Model	11	14,2549	1,2959	4,94	<,0001
Class CAB	3	13,0953	4,3651	16,66	<,0001
Class HC	2	0,1025	0,0512	0,20	0,8232
Class HC x Class CAB	6	1,0569	0,1762	0,67	0,6726
Erro	39	10,2212	0,2621		
Total	50	24,4760			

It was found that both *P. bracteosa* and *A. pyrifolium* emitted a higher amount of tillers when the individual presented a stump circumference larger than 30 cm. It was also verified that classes smaller than 15 cm showed a lower emission of tillers for both species (Table 5).

Table 5. Tukey-Kramer test results for the mean number of sprouts per stump for *Poincianella bracteosa* and *Aspidosperma pyrifolium*, Floresta-PE, Brazil.

Tabela 5. Resultados do teste de Tukey-Kramer para as médias do número de perfilhos por cepa para *Poincianella bracteosa* e *Aspidosperma pyrifolium*, Floresta-PE, Brasil.

Classes of CAB	Interval of Classes (cm)	Number of stumps	Number of sprouts stump ¹			Standard deviation
			Minimum	Maximum	Mean	
<i>Poincianella bracteosa</i> (Tul.) L. P. Queiroz						
I	0 +- 15	276	1	20	3,42 c	2,40
II	15 +- 30	232	1	18	5,63 b	3,27
III	30 +- 45	70	2	23	8,99 a	4,40
IV	≥ 45	59	1	29	9,63 a	6,37
<i>Aspidosperma pyrifolium</i> Mart						
I	0 +- 15	10	3	11	4,60 c	2,59
II	15 +- 30	17	4	24	10,71 b	5,25
III	30 +- 45	19	7	55	15,32 ab	10,73
IV	≥ 45	5	12	37	25,80 a	10,40

Means followed by the same letter do not differ at the 5% level according to Tukey-Kramer.

Médias seguidas de mesma letra não diferem ao nível de 5% de probabilidade conforme o teste de Tukey-Kramer.

The characteristics found for *P. bracteosa* were similar to those found by Figueirôa et al. (2008) when researching a species of the same genus, finding that it survived the clear-cut in a time interval longer than one year, independent of the climatic season. In the same way, it was observed that *A. pyrifolium* showed higher performance regarding regrowth, with a high number of shoots per stump. This characteristic can be found in the long-term for both species; therefore, it is suggested to perform selective cutting if the survival of the regrowth is confirmed, considering that there is self-thinning.

Reconstitution of the original biomass

The adjusted equations presented a good coefficient of determination (R^2_{aj}), ranging from 0.8045 to 0.8955, with the highest values observed in equations 4 and 5 (Table 6). However, because the coefficients β_0 e β_2 of equation 5 were not significant and because they presented a lower

F value when compared to equation 4, this equation was not considered a good estimator. Thus, Equation 4 was selected for also having the lowest IF value (1.4967) and a high F value.

Table 6. Estimation of the parameters and precision measurements of the adjusted equations to estimate the diameter at breast height of the trees as a function of the stump diameter at the base in an area under forest management, Floresta-PE, Brazil.

Tabela 6. Estimativa dos parâmetros e medidas de precisão das equações ajustadas para estimar o diâmetro a altura do peito das árvores em função do diâmetro a altura da base das cepas em uma área sob manejo florestal, Floresta-PE, Brasil.

Equation	Coefficients			$R^2_{Aj.}$	S_{yx}	$S_{yx}\%$	IF	F
	β_0	β_1	β_2					
1	1,54059	0,44831	-	0,8690	1,3266	21,95	2,1848	6149,1**
2	-	0,54569	-	0,8045	1,6204	26,82	2,6701	16718,5**
3	1,22488	0,50913	-0,00186	0,8706	1,3184	21,82	2,1702	3119,3**
4	0,07859	0,75778	-	0,8955	0,1754	10,66	1,4967	7947,7**
5	0,05790 ^{ns}	0,77880	-0,0048 ^{ns}	0,8954	0,1755	10,67	1,4967	3970,4**
6	1,09349	0,71947	-	0,8708	1,3176	21,81	2,1700	6246,4**
7	-2,41505	1,95786	-	0,8688	1,3276	21,97	2,1865	6139,0**
8	-3,42051	3,17293	-	0,8606	1,3683	22,64	2,2535	5724,9**
9	0,24618	1,01826	-	0,8503	1,4179	23,47	2,3352	11060,4**
10	1,36669	0,21279	-	0,8708	1,3172	21,80	2,1693	12890,3**

$R^2_{Aj.}$ = adjusted coefficient of determination; S_{yx} = standard error of the estimate; $S_{yx}\%$ = coefficient of variation in %; IF = Furnival Index; F = value of F of the analysis of variance; ** = significant at 99% probability.

$R^2_{Aj.}$ = coeficiente de determinação ajustado; S_{yx} = erro padrão da estimativa; $S_{yx}\%$ = coeficiente de variação em %; IF = Índice de Furnival; F = valor de F da análise de variância; ** = significativo a 99 % de probabilidade.

The data used for modeling were well related (Figure 1a), since a tendency of higher DBH as a function of DAB can be observed. However, it is noted that the larger the DAB, the higher the DBH variation, which can be explained by the different species that present different shapes and heights. A uniform distribution of the model 4 residues was observed, being adopted for estimating the DBH of the trees, and with some values overestimating the DBH for the lowest DAB classes (Figure 1b).

Figure 1. Distribution of observed and estimated values (a) and distribution of percentage residual values (b) for the reconstruction of the diameter at breast height of the trees ((DBH) as a function of the stump diameter at the base (DAB) in an area under forest management, Floresta-PE, Brazil.

Figura 1. Distribuição dos valores observados e estimados (a) e distribuição dos valores residuais percentuais (b) para a reconstrução do diâmetro à altura do peito das árvores (DAP) em função do diâmetro a altura da base das cepas (DAB) em uma área de Caatinga, Floresta-PE, Brasil.

In the estimation of the biomass reconstitution from the Silva and Sampaio equation (2008), a high variation was observed in the biomass that should have the vegetation at the time of cutting in 2013, assuming values from 6381.25 to 28827.09 kg ha⁻¹, with an average of 17186.16 kg ha⁻¹. The data found did not differ from that found by Lima Júnior et al. (2014) for the Caatinga vegetation in the municipality of Petrolina, Pernambuco, with estimated values of biomass being between 5930 and 60740 kg ha⁻¹.

The obtained results also resemble those found by Sampaio et al. (1998) estimating biomass after cutting and burning in the Caatinga area in the municipality of Serra Talhada, also in Pernambuco, with an estimated 4000 and 17000 kg ha⁻¹, respectively, at two and six years of age. In the area with only the cut, the biomass was 7000 kg ha⁻¹ at two years and 30000 kg ha⁻¹ at six years.

In studying two Caatinga areas in Santa Luz, Bahia and Petrolina, Pernambuco, found total biomass values ranging from 35000 to 156000 kg ha⁻¹. This author also estimated total biomasses for 112 Caatinga areas, observing values between 2000 and 156000 kg ha⁻¹, and that 60% of these areas did not exceed 20000 kg ha⁻¹, as is the case of the anthropized area of the present study. It is worth mentioning that for Sampaio and Freitas (2008), aerial biomass in Caatinga areas is also a consequence of water availability in each site and that the biomass ranges from 30000 to 50000 kg ha⁻¹.

CONCLUSIONS

The tillering for *Poincianella bracteosa* and *Aspidosperma pyrifolium* was influenced by the circumference size, but not by the stump height.

The estimated average biomass was similar to areas submitted to anthropic intervention, and its reconstitution could be an auxiliary tool in the control of illegal deforestation by environmental agencies.

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