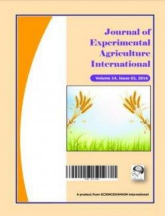

Journal of Experimental Agriculture International

30(5): 1-10, 2019; Article no.JEAI.46435
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Floristic Characterization and Phytosociology of a Vegetation in a Caatinga Area in Brazil

Francisco T. A. Moreira[1], Lúcio V. C. Araújo[1], Girlânio H. Silva[2*], Lyanne S. Alencar[1] and Ikallo G. N. Henriques[1]

[1]Federal University of Campina Grande (UFCG), Patos, PB, Brazil.
[2]São Paulo State University (UNESP), Botucatu, SP, Brazil.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2019/46435
Editor(s):
(1) Dr. Mario Lettieri Teixeira, Professor, Federal Catarinense Institute – Campus Concordia, Brasil.
Reviewers:
(1) M. I. Zuberi, Gono University, Bangladesh.
(2) Rahim Foroughbakhch, Universidad Autónoma de Nuevo León, Mexico.
(3) Junir Antonio Lutinski, Universidade Comunitária da Região de Chapecó, Brazil.
Complete Peer review History: http://www.sdiarticle3.com/review-history/46435

Original Research Article

Received 06 November 2018
Accepted 17 January 2019
Published 11 February 2019

ABSTRACT

The present study characterizes the floristic and phytosociological characters in the paraibano semiarid in Caatinga area. For the phytosociological survey 25, sample units with dimensions of 20 m x 20 m distributed randomly were used in order to collect the name of the species, the circumference at ground level (CFL), the circumference at breast height (CBH), the total height of the individuals and the state trees. The total surface of the area was 323.65 ha and 255.85 ha of shrub by arboreal vegetation what represent 79% of the area with vegetation, the remaining 21%, were classified as clean field, reservoirs, courses of water and highways, totaling 67.8 hectares. To the floristic composition 2.362 individuals were observed, which ones, 22 species belonged to 14 families. Considering the habit of the found species, 68% can be considered as arboreal and 32% as shrubby. The vegetation can be classified as a closed shrub-arboreal Caatinga. The most representative species and with the higher importance value (IV) in the area were *Poincianella pyramidalis*, *Mimosa tenuiflora*, *Aspidosperma pyrifolium* and *Anadenanthera colubrina*. The basal area average was 11.68 m²/ha. The species with higher basal area were *P. pyramidalis*, *M. tenuiflora*, *A. colubrina* and *A. pyrifolium.*

**Corresponding author: E-mail: girlanio_holanda@hotmail.com;*

Keywords: Measurement; forest inventory; floristic composition, phytosiciology; steppic savannah biome.

1. INTRODUCTION

The Caatinga biome is in semiarid region of northeastern states of Brazil, extending to the northeast of the state of Minas Gerais. It is estimated that the total area covered by this Biome is about 1.000.000 km^2 [1]. The annual precipitation in the region is less to 1000 mm a year, with rains distributed irregularly. Moreover, the solar radiation and temperature averages are high, while the relative levels of moisture and cloudiness are the lowest in the region of Brazil [2].

The Caatinga has an inappropriate usage history of their land, with the transformation of native forests in Agroecosystems. Due to this fact, 45% of the Caatinga has been modified by human activities [3]. However, studies indicate that this value is underestimated [4]. Despite the lack of knowledge about the Biome [5], the Caatinga has been systematically devastated.

The exploration of Caatinga may take an irreversible process of degradation and consequent desertification. The native forest remnants, are located almost exclusively within semiarid, playing an important role in the socio-economy [6]. However, the forest cover of the semiarid region has been drastically reduced by the lack of proper management and the type of exploration adopted.

The Caatinga lost part of its native vegetation as a result of inadequate management. Due to this fact, there is damage to the soil and water bodies in the region [7]. Much of the environmental degradation problems in Caatinga are related to the absence of adequate planning of land occupation and miss respect to the characteristics of the various ecosystems, particularly its richness and diversity [2].

So, describe richer and more abundant families, already sampled and reported in previous phytosociological studies of the Caatinga vegetation, give more knowledge about this biome as a whole, in order to determine its patterns of distribution, abundance and relation with environmental factors based on quantitative data and floristic connections [8].

In this sense, the aim of this study was to characterize and elaborate a phytosociological and floristic diagnosis of representative area located in Caatinga Biome.

2. MATERIALS AND METHODS

2.1 Characterization of the Study Area

The research area is part of Tamandua Farm, owned by the Moco Agropecuaria company, located in Santa Terezinha (PB), Brazil. The area is located in the micro-region of low Hinterland Piranhas, with altitude ranging between 250 and 310 meters, in the coordinates 07º00 'S and 37º23' W.

According to the [9] climate classification, the region of the study is characterized as having type climate Bsh, semiarid region, marked by rainy and dry season [10].

The area is part of a geomorphologic unit with extended low plain ground, smooth-rolling predominant relief, with residual elevations scattered in the landscape, in which the granite rock shows exposed or minimal soil capping and vegetation [11]. The vegetation in which the study was conducted is characterized as Steppic savannah [12] and the area have not a history of deforestation.

2.2 Environmental Characterization of the Area

The first step to characterize the environmental area was conducting a topographic survey using a GPS navigation. In this phase were used aerial photographs with high resolution of the whole farm, provided by the owner. This procedure defined the perimeter of the studied area. For making the maps was used TrackMaker® professional version 4.7 program [13].

After defining the perimeter, was raised areas with vegetation, grassland, water reservoirs, waterways and roads. The representation of terrain elevation through colors, i.e. the hypsometry area was made using the computer program Surfer® version 10 [14].

The hypsometric chart (Fig. 2) shows the altitude ranging from 230 m to 320 m, and can be observed that these altitudes are commonly found throughout the region.

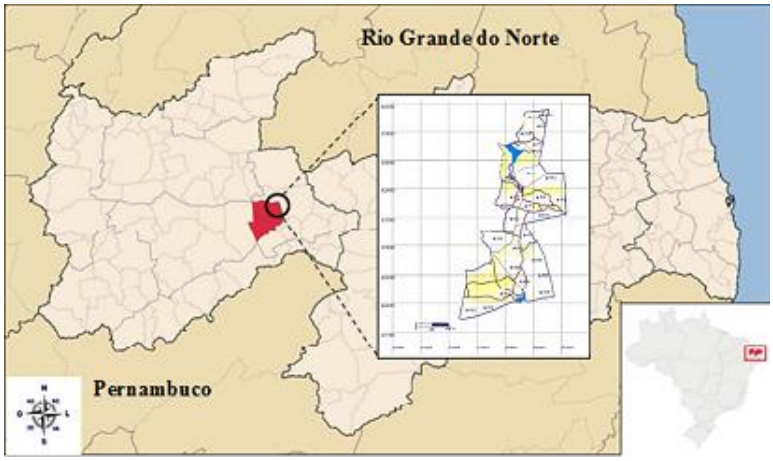

Fig. 1. Map of the study area with vegetation (white), Grassland (yellow), bodies of water (blue) and distribution of sample units. Santa Terezinha, PB, Brazil

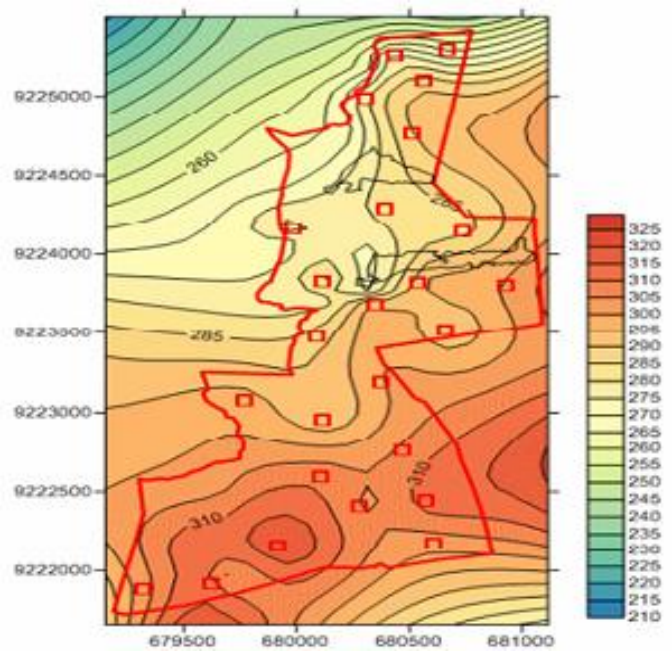

Fig. 2. Hypsometric chart map of the study area. Santa Terezinha, PB, Brazil

The assessment of the ground truth was done through five visits to collect 25 samples of 20 m x 20 m in the area.

2.3 Floristic Survey

The floristic survey of the shrub-tree layer was carried out through five field campaigns during summer season, in order to go through the greatest extensions of the study area, with a view to observe the greatest possible number of established plant species. In addition to the campaigns, they were held collections in the plots used for phytosociological. To collect the plant material was used pruning shears. The collected material was properly prepared and sent to the Herbarium of the Academic Unit of Forestry (CSTR-UFCG) for identification.

For the classification of the species was adopted the [15] system. As for the floristic comparisons, we used different work carried out in Caatinga vegetation.

2.4 Phytosociological Survey

For the phytosociological survey of the area, was used sample units with dimensions of 20 m x 20 m (400 m²), which were distributed randomly. In each unit was described, the common name, the circumference at ground level (CFL), the circumference at breast height (CBH), the total height of the individuals and the state trees (alive or dead). Were considered for data collection purposes, all living or dead, still standing, and as inclusion criteria, total height ≥ 1.0 meters, and circumferences at chest level ≥ 6.0 cm, following the recommendation of the Forest Management Network Measurement Protocol of Caatinga [16]. Circumferences and heights of the plants were measured with the aid of tape and retractable metal rod, graduated in meters with divisions of 50 cm. After measuring the phytosociological parameters, were calculated:

I - Relative Density (RD):

$$RD = (Ni \times 100) / n$$

Where:

Ni = number of units of the species i;
N = total number of units.

II - Absolute Frequency (AF):

$$AF = (Pi \times 100) / P$$

Where:

Pi = number of plots in which the species occurred;
P = total number of plots.

III - Relative Frequency (RF):

$$RF = (AF \times 100) / \Sigma AF$$

IV - Relative Dominance (DoR):

$$DoR = (BA / TBA) \times 100$$

Where:

BA = basal area of each unit of the species;
TBA = sum of the basal areas of all species

V - Importance Value (IV):

$$IV = RD + DoR + RF$$

3. RESULTS AND DISCUSSION

3.1 Characterization of the Study Area

The total area of the studied was 323.65 ha. It was also found that the total study area, 255.85 he showed shrub and tree vegetation, which represents 79% of the area with vegetation. After the 25 sampling units used in the characterization of vegetation in the experimental area the definition of areas with vegetation were distributed. The remaining 21% after aerial photography analysis, were classified as areas of grassland, reservoirs, water bodies and roads, totaling 67.8 ha (Fig. 1).

3.2 Data Analysis

The sampling sufficiency was verified by the collector curve (Fig. 3). Was observe initial increase of trend and, to the extent that the sampled area increased, tended to stabilize indicating that sampling of the species in the experimental area was enough. The curve tended to stabilize with 9600-10000 m^2 of area sampled, indicating that sampling minimum area was satisfactory for the species (trees and shrubs) in the study area.

Regarding the floristic composition, were found a total of 2.362 individuals, including 22 species belonging to 14 families (Table 1). However, one of the observed species was not identified botanically, and that at the time of collection of botanical material, it had no fertile material. The percentage of dead individuals was 4%. Whereas the habit of the species found, 68% can be considered as a tree and shrub 32%.

Among the ten species that stood out in relation to the importance value, we can highlight the *P. pyramidales*, in which it had the highest importance value (Fig. 4), which was mainly due to the high number of individuals of species in the experimental area [17-18].

Considering the horizontal structure, it was observed the remarkable presence of the species *P. pyramidalis* and *C. blanchetianus* presenting higher RD in comparison with other species.

It was observed that the ordering of the 22 sampled species by their importance values followed, mainly, the relative dominance (Table 2), indicating the number of individuals was essential to the determination of IV of the species, as was the case *P. pyramidalis*, *M. tenuiflora*, *A. colubrina* and *A. pyrifolium* decreasingly.

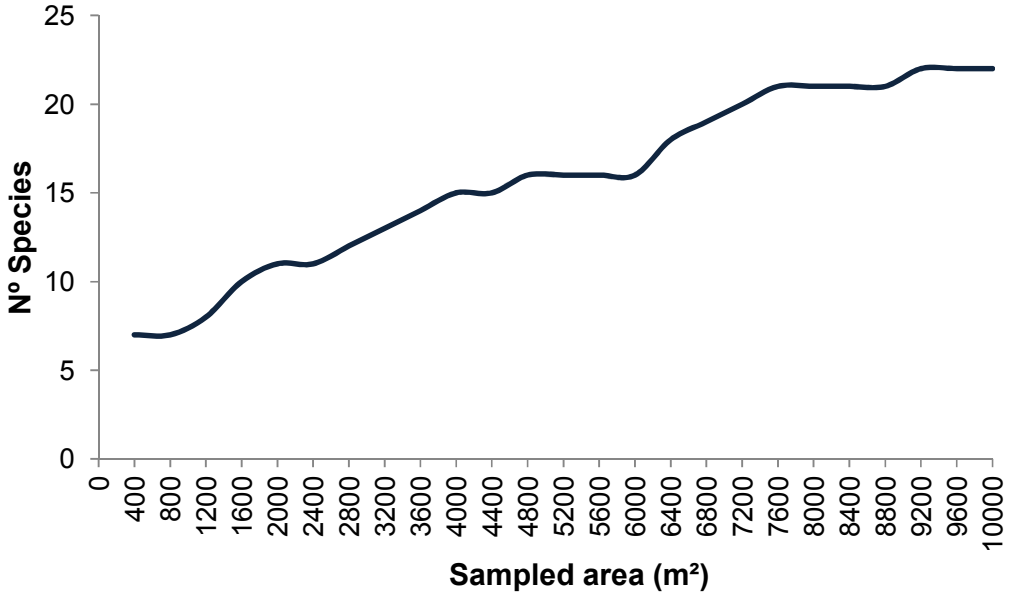

Fig. 3. Sampling effort of the species in the study area. Santa Terezinha, PB, Brazil

Table 1. Floristic ratio of woody species in the study area. Santa Terezinha, PB, Brazil

Family/Specie	Common name	Habit
Anacardiaceae		
Myracrodruon urundeuva Fr. All.	Aroeira	Arboreal
Apocynaceae		
Aspidosperma pyrifolium Mart. Ex. DC	Pereiro	Arboreal
Bignoniaceae		
Tabebuia impetiginosa Mart. Ex. DC	Pau d´arco	Arboreal
Bombacaceae		
Pseudobombax marginatum St. Hil.	Embiratanha	Arboreal
Burseraceae		
Commiphora leptophloeos Mart. JB	Imburana	Arboreal
Capparaceae		
Capparis flexuosa L. L.	Feijao bravo	Shrub
Combretaceae		
Combretum leprosum Mart. & Eicher	Mofumbo	Shrub
Erythroxylaceae		
Erythroxylum pungens OE Schulz	Rompe gibao	Shrub
Unknown		
Unknown	Cipo de vaqueiro	Shrub
Fabaceae		
Amburana cearensis Allemão AC Smith	Cumaru	Arboreal
Bauhinia cheilantha	Mororo	Arboreal
Poincianella pyramidalis (Tul.) LP Queiroz	Catingueira	Arboreal
Libidibia ferrea	Pau ferro	Arboreal
Senna macranthera (Colladon) Irwin & Barneby	Sao Joao	Shrub
Mimosaceae		
Anadenanthera colubrina (Vell.) Brenan	Angico	Arboreal
Mimosa tenuiflora (Willd) Poir.	Jurema preta	Arboreal
Piptadenia stipulacea (Benth) Ducke	Jurema branca	Arboreal
Rhamnaceae		
Ziziphus joazeiro Mart.(HELZJ)	Joazeiro	Arboreal

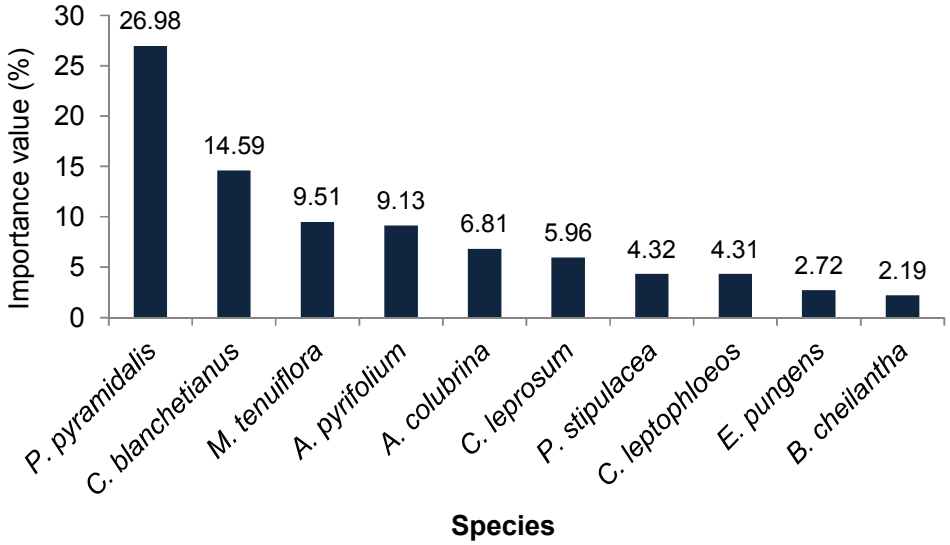

Fig. 4. The ten species with the highest Importance value (IV). Santa Terezinha, PB, Brazil

Table 2. Values of phytosociological parameters for the species sampled, Santa Terezinha, PB, Brazil

Cientific name	RD	AF	RF	DoR	IV
A. cearensis	0.08	8.00	0.87	0.04	0.33
A. colubrina	3.30	64.00	6.99	10.14	6.81
A. pyrifolium	8.98	76.00	8.30	10.11	9.13
B. cheilantha	2.03	36.00	3.93	0.59	2.19
C.s flexuosa	0.08	8.00	0.87	0.03	0.33
C. quercifolius	0.68	32.00	3.49	1.40	1.86
C. leprosum	7.11	76.00	8.30	2.47	5.96
C. leptophloeos	2.24	52.00	5.68	5.02	4.31
C. blanchetianus	26.7	96.00	10.5	6.58	14.5
C. cf. alagoensis	0.55	12.00	1.31	0.15	0.67
E. pungens	1.65	44.00	4.80	1.70	2.72
Unknown	0.34	12.00	1.31	0.13	059
L. ferrea	0.34	4.00	0.44	0.15	0.31
M. tenuiflora	8.93	76.00	8.30	11.29	9.51
Dead	4.02	84.00	9.17	4.97	6.05
M. urundeuva	0.13	8.00	0.87	0.12	0.37
P. stipulacea	2.92	76.00	8.30	1.73	4.32
P. pyramidalis	29.1	100.0	10.9	40.89	26.9
P. marginatum	0.25	24.00	2.62	0.85	1.24
Sebastiana sp.	0.08	4.00	0.44	0.05	0.19
S. macranthera	0.17	8.00	0.87	0.02	0.36
T. impetiginosa	0.08	8.00	0.87	0.19	0.38
Z. joazeiro	0.17	8.00	0.87	1.38	0.81

RD = relative density (%); RF = relative frequency; AF = absolute frequency; DoR = relative dominance (%); IV = importance value (%)

Of the 2.362 sampled individuals, 2.232 individuals are distributed in the first three classes, representing approximately 94.5% of all samples with diameters less than 15 cm. (Table 3). The estimated cylindrical volume was approximately 52.1 m^3/ha.

The basal area average was found to be 11.68 m²/ha and is considered a low value in relation to other studies conducted in semiarid region, what can be due to the distribution of the study samples. The species that had higher basal area were *P. pyramidalis, M. tenuiflora, A. colubrina* and *A. pyrifolium* (Fig. 5).

Structurally, the following vegetation characteristics were evident: the majority of individuals in the class 3.0 to 4.5 m high, with some emerging species, reaching about 10 m or more, with relevant importance in community structure, as equal among the most IV, as *P. pyramidalis, M. tenuiflora and A. colubrin*a due to significant numbers of individuals and basal area (Fig. 6). It was also clearly visible two strata, one tree and other shrubs. In the tree layer, with a predominance of individuals with height greater than 4.5 m.

4. DISCUSSION

The results of this study show there is considerable number of species richness in the area, even if compared with inventories in other areas of Caatinga [18-20].

In the arboreal component occurred 15 species, distributed in nine families, especially Mimosaceae, Fabaceae and Euphorbiaceae, the first family with four species and the last two with three and two species, respectively, and the other families with only one specie.

In the shrub component occurred seven species, distributed in six families. Euphorbiaceae, with two species of shrubs, being considered the richest family in this component.

Without considering the habit of the species, is observed families with the highest species richness, were Fabaceae with five species, followed by Euphorbiaceae families with four species and Mimosaceae with three species. The other families had only one specie. Similar results were obtained in studies performed in the Caatinga of the Serido region [21-22]. Other research carried out within the same farm was noted that families with the highest number of species were Euphorbiaceae, Caesalpinaceae and Mimosaceae [23].

Table 3. Diametric distribution of individuals (N), percentage of individuals, basal area (BA) and volume per hectare (V/he), according to the DAB (diameter at the base). Santa Terezinha, PB, Brazil

Class (cm)	N	%	BA m^3/ha	V/ha
0.0 – 5.0	1148	48.60	1.2327	3.5908
5.0 – 10.0	844	35.73	3.2361	11.997
10.0 – 15.0	240	10.16	2.8042	12.169
15.0 – 20.0	82	3.47	1.8899	9.6911
20.0 – 25.0	31	1.31	1.2252	6.2648
25.0 – 30.0	11	0.47	0.6681	3.9533
30.0 – 35.0	3	0.13	0.2519	1.7177
35.0 – 40.0	2	0.08	0.2274	1.6271
40.0 – 45.0	1	0.04	0.1450	1.0877
Total	2362	100	11.680	52.099

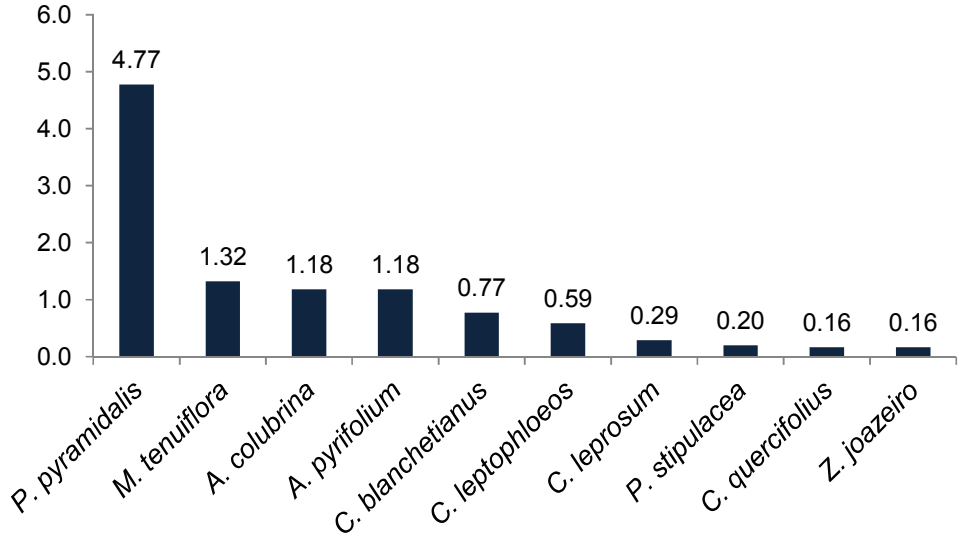

Fig. 5. Relation of the ten species with higher basal area (m^2). Santa Terezinha, PB, Brazil

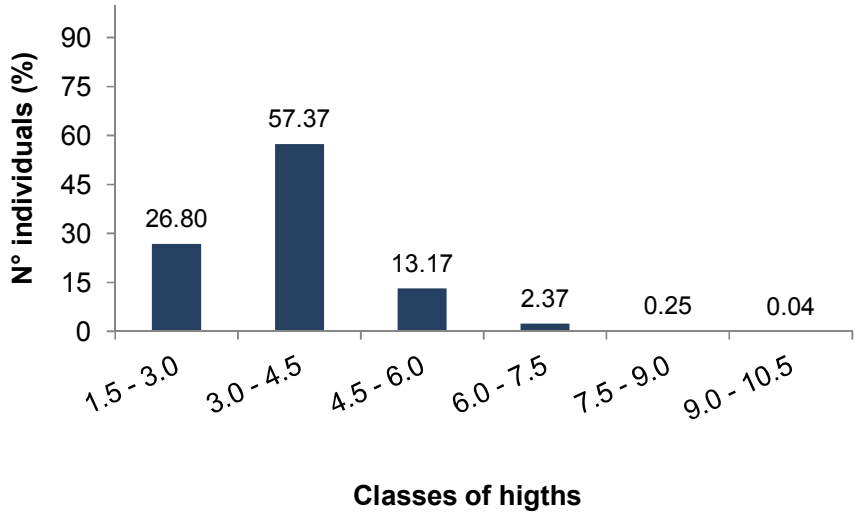

Fig. 6. Percentage of individuals in classes (cm). Santa Terezinha, PB, Brazil

The high species richness of Fabaceae in the study area indicates their status as the main family [24]. Leguminous are constantly seen in inventories in areas of savannah, as in crystalline soffits [25,19], sandy soils of sedimentary basins [26], or in areas with a predominance of rocky outcrops [27], or surveys restricted to the woody component [28] which include other habits [18].

The species that have held the highest number of individuals sampled were *P. pyramidalis*, *C. blanchetianus* and *A. pyrifolium*. The *P. pyramidalis* species and *C. sonderianus* are considered those that stood out most in the number of individuals in several works in areas of Caatinga [29-30].

The five species that had higher relative density were *P. pyramidalis*, *C. blanchetianus*, *A. pyrifolium*, *M. tenuiflora* and *C. leprosum*. The forest specie *P. pyramidalis* showed higher relative dominance. Other studies, find in an area of Caatinga in good condition, the *P. pyramidalis* has the second highest importance value [31]. The prevalence of *P. pyramidalis* on other species is due to the large number of individuals (688) and also by the way these individuals are distributed throughout the sampled area. The species were present in 100% of sampled plots, thus affecting substantially the highest importance value.

With regard to the relative frequency, the five species that stood out were: *P. pyramidalis*, dead trees, *A. pyrifolium*, *M. tenuiflora* and *C. leprosum*, and the last three species showed similar percentages (8.3%).

The majority of individuals (94%) were positioned in the first three diameter classes, numerically decreasing with increasing the diameter, to form a graphic format of inverted "J". Thus, in the event of a disturbance on vegetation, older individuals (larger diameter class), in a less quantity, may die younger individuals, along with regenerating quickly repopulate the disturbed area. The presence of many individuals with stem diameter in the initial diameter classes shows an initial stage of secondary feature by the studied vegetation [32].

The high diversity of species found in the study area may have several causes, such as the presence of large flagstones, microhabitats in the region, numerous banks of rivers and streams. Furthermore, several studies indicate that these environments serve as refuges, and to minimize the effects of drought, it enables a higher probability of survival of various species. Moreover, the vegetation conservation state may have contributed to the high richness [29,33].

5. CONCLUSIONS

Athough a small area sampled in this study, the area has the capacity to store large floristic biodiversity, and it must therefore be conserved in order to serve as reference for other Caatinga areas in the region.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Queiroz MA. Caatinga plant genetic resources for the development of the Brazilian Semi-Arid (Caatinga Plant Genetic Resources for the Development of the Brazilian Semiarid). Revista Brasileira de Geografia Física. 2012;4(6):1135-1150.
2. Souza BI, Menezes R, Artigas RC. Effects of desertification on species composition of the Caatinga biome, Paraíba / Brazil. Geographical Research. 2015;88(1):45-59. Available:https://doi.org/10.14350/rig.44092
3. MMA - Ministry of the Environment. Monitoring of Brazilian biomes: Caatinga biome. Brasília: MMA; 2010.
4. Castelletti CHM. How much is left of the caatinga? A preliminary estimate. In: Leal, IR, Tabarelli M, Silva JMC. Ecology and conservation of the caatinga. Recife, UFPE University Ed; 2003.
5. Moro MF, Araújo FS, Rodal MJN, Martins FR. Synthesis of the floristic and phytosociological studies carried out in the Brazilian semiarid region. In: Eisenlohr PV, Felfili JM, Melo MMRF, and MeiraNeto JAA. Phytosociology in Brazil: Methods and case studies. Publisher of the Federal University of Viçosa, Viçosa. 2015;II.
6. Silva KA, Santos JMFF, Santos DM, Ferraz EMN, Araújo EL. Spatial variation in the structure and composition of the herbaceous community in the semiarid region of northeastern Brazil. Brazilian Journal of Biology. 2013;73(1):135-148. Available:http://dx.doi.org/10.1590/S1519-69842013000100015
7. Junior LRP, Alberici PA, Kallianna DA. Floristic composition and phytosociology of a caatinga fragment in monteiro, paraíba. Holos. 2013;6(1):73-87.
8. JTC Jr, Drumond MA. Comparative study of the phytosociological structure of two caatinga fragments at different levels of conservation. Brazilian Forest Research. 2014;34(80):345-355.
9. Alvares CA, Stape JL, Sentelhas PC, Moraes G, Leonardo J, Sparovek G. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift. 2013; 22(6):711-728.
10. Insa, National Institute of the Semi-Arid. Available:http://www.insa.gov.br/grupodepesquisala vouraxerofila / index.php? Option = com_cont and nteview = articleeid = 56eItemid = 62elang = en (Accessed 8 January 2013)
    Sudema. Update of the forest diagnosis of the State of Paraíba. João Pessoa; 2004.
11. Ibge. Map of vegetation of Brazil. IBGE, Rio de Janeiro; 1993.
12. Geo Studio Technology. Available:https://www.trackmaker.com/main/pt/baixar-software-gps-profissional (Accessed 29 December 2018)
13. Golden Software, Inc. 1997. Surfer® for Windows Version 6. Available:https://www.goldensoftware.com/products/surfer (Accessed 29 December. 2018)
14. Cronquist A. An integrated system of classification of flowering plants. New York, Columbia University Press; 1981.
15. Forest Management Network of the Caatinga: Protocol of measurements of permanent plots / Scientific Technical Committee. Recife: Associação Plantas do Nordeste; 2005.
16. Costa GM, Cardoso D, Queiroz LP, Conceição AA. Local variations in floristic richness in two caatinga ecoregions. Rodriguésia, Botanical Garden Research Institute of Rio de Janeiro. 2015;66(3):685-709. DOI: 10.1590 / 2175-7860201566303
17. Pinto MS, Sampaio EV, Nascimento LM. Floristic and vegetation structure of an altitude brejo in fishing, PE, Brazil. Northeastern Journal of Biology. 2012; 21(1):47-79.
18. WJ Ax, Silver APN, Mello AA. Floristic composition in areas of caatinga and brejo de altitude in Sergipe State, Brazil. Check List. 2012;8(1):1089-1101. Available:http://dx.doi.org/10.15560/8.6.1089
19. Ferreira EVR. Floristic composition, community structure and seed dispersal syndrome of a caatinga remnant in Poço Verde - Sergipe. Dissertation Master. São Cristovão: Federal University of Sergipe. 2011;81.
20. Oliveira DG, Silver AP, Ferreira RA. Herbaceous of the Caatinga: Floristic composition, phytosociology and strategies of survival in a plant community. Brazilian Journal of Agricultural Sciences. 2013;8(4): 623-633.

Available:http://dx.doi.org/10.15628/holos.2012.1188

21. Andrade-Lima D. The caatinga dominium. Brazilian Journal of Botany. 1981;4(1): 149-153.
22. Araújo LVC, Paulo MCS, Paes JB. Dendrometric characteristics and basic density of the Jurema-preta (*Mimosa tenuiflora* (Willd.) Poir.) From two regions of the state of Paraíba. Caatinga Magazine. 2007;20(1):89-96.
23. Cardoso DBOS, Queiroz LP. Caatinga in the context of a community goal: Evidence of biogeography, phylogenetic patterns and abundance of species in Leguminosae. In: Carvalho CJB, Almeida EAB. (Eds). Biogeography of South America: Patterns and processes. Roca, São Paulo; 2011.
24. Lima IB, Barbosa VMR. Floristic composition of RPPN farms farm, in Paraíba, Brazil. Northeastern Journal of Biology. 2014;23(1):49-67.
25. Rocha PLB, Queiroz LP, Pirani JR. Plant species and habitat structure in a sand dune field in the Brazilian Caatinga: A homogenous habitat harbouring an endemic biota. Brazilian Journal of Botany. 2004;27(1):739-755.
Available:http://dx.doi.org/10.1590/S0100-84042004000400013
26. Gomes P, Alves M. Floristic diversity of two crystalline rocky outcrops in the Brazilian northeast semi-arid region. Brazilian Journal of Botany. 2010;33(1): 661-676.
Available:http://dx.doi.org/10.1590/S0100-84042010000400014
27. We read JR, Rodal MJN. Phytosociology of the woody component of a section of the caatinga vegetation in Serra da Capivara National Park, Piauí, Brazil. Acta Botânica Brasília. 2002;16(1):23-42.
28. Lima IB, Barbosa VMR. Floristic composition of RPPN farms in Paraíba, Brazil. Northeastern Journal of Biology. 2014;23(1):49-67.
29. Araújo Filho JA, Barbosa TML. Agroforestry management of the caatinga: A proposal of a production system. In Oliveira TS, Romero RE, Assis Junior RN, Silva JRCS. (Eds). Agriculture, sustainability and the semi-arid. Fortaleza: Brazilian Society of Soil Science; Federal University of Ceara; 2000.
30. Andrade LA, Pereira IM, Leite UT, Barbosa MRV. Analysis of the cover of two caatinga phytophysiognomies, with different use histories, in the city of State, Brazil. Cerne Magazine. 2005;11(3):253-262.
31. Junior LRP, Alberício PA, Kallianna DA. Floristic composition and phytosociology of a caatinga fragment in monteiro, paraíba. Holos. 2013;6(1):73-87.
32. Albuquerque UP, Araújo EL, El-Deir ACA, Lima ALA, Souto A, Bezerra BM, Ferraz EMN, Freire EMX, Sampaio VSB, Las-Casas FMG, Moura GJB, Pereira GA, Melo JG, Ramos MA, Rodal MJN, Schiel N, Lyra NRM, Alves RRN, Azevedo-Júnior SM, Telino-Júnior WR, Severi W. Caatinga Revisited: Ecology and conservation of an important seasonal dry forest. The Scientific World Journal. 2012;205182(1): 1-18.
Available:http://dx.doi.org/10.1100/2012/205182

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/46435