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Survival of Forest Species of the Caatinga in Ciliary Plantations in the State of Paraíba, Brazil

Maria José de Holanda Leite[1*], Maria do Carmo Learth Cunha[2], Rafael Rodolfo Melo[3] and Maria José Martins Fausto Almeida[3]

[1]Federal University of Alagoas (UFAL), Maceió, AL, Brazil.
[2]Federal University of Campina Grande (UFCG), Patos, PB, Brazil.
[3]Federal University of Piauí (UFPI), Teresina, PI, Brazil.

Authors' contributions

This work was carried out in collaboration among all authors. Author MJHL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MCLC and RRM managed the analyses of the study. Author MJMFA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Riparian forests have peculiar characteristics in relation to architecture and flowering, which are intrinsically linked to the high water content of the soil and the air where they develop due to both the superficiality of the water table and periodic flooding. The aim of this research was to assess the survival or establishment of seedlings in the field through the collection of survival information in order to verify which species group(s) is most feasible for recovering of riparian forest in Caatinga areas. The riparian plantations were conducted in three rural communities from March to April, at the Riacho Trapiá, Rio Espinharas and Rio da Cruz rivers, municipality of Maturéia-PB, respectively for three years (2003, 2004 and 2005). Twenty-two native species were used, covering six pioneers, eight secondary, five climaxes and three of undetermined ecological group. The results showed that the pioneer and secondary species had better survival performance in the areas of riparian stand plantations, this may have occurred because they had the capacity to adapt in places with adverse conditions, which demonstrates their indication for recovering of riparian forest.

**Corresponding author: E-mail: maryholanda@gmail.com;*

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1. INTRODUCTION

The ciliary forests have peculiar characteristics in relation to architecture and flowering, which are intrinsically linked to the high water content of the soil and the air where they develop caused by both the superficiality of the groundwater and periodic floods [1]. This term of ciliary forest refers to its similarity with the eyelashes of our eyes. These forest systems are established naturally in bands on the banks of rivers and streams, in the vicinity of lakes, dams and springs, which functions as a reducer of silting, degradation of the environment, as a natural means of processing and transformation of environmental diversity [1].

It is worth noting that the riparian forest also works, as ecological corridors, linking forest fragments, since the physical retention of the roots, protects the soil against erosion, by decreasing the impact of water on the soil through the leaves and stem and by the soil coating through the formation of the litter layer. The intrinsic relationship that these forest formations maintain with the bodies of water, makes them preponderantly important for maintaining the integrity of the local ecosystems. Thus, due to the vulnerability of the riverbanks, the establishment of a vegetation in its surroundings was fundamental for the stabilization and permanence of these sites [2]. In order to protect the rivers, this influences directly on water quality, in the maintenance of the hydrological cycle in the river basins, avoiding the erosion process of the margins and the silting [3]. However, even in the face of the immense importance of these areas, it is noted that the ciliary forests over time to the detriment of the various economic interests have been highly compromised.

According to Oliveira et al. [2] the areas located near the rivers have been suffering from the intense degradation process in their margins, provoked especially by the disorderly occupation of man in the exploitation of natural resources. Among the anthropogenic pressure factors are the occupation of land itself since the beginning, without a planning [4], as well as deforestation aiming the use of wood, burnt for the generation of energy and the implantation of swiths and pastures [3].

It is also important to highlight that among the semiarid areas of the northeast, the ciliary forests of Paraíba is the most affected by environmental degradation, due to the presence of a significant number of river basins and a high number of inhabitants, suffering. Therefore, strong pressure in the ciliary areas [5]. These data become more worrying when considering water problems related to the Semiarid region, such as the low water flow of rivers due to the temporal variability of precipitations and the predominance of shallow soils based on crystalline rocks reflecting in reduced water exchange between river and adjacent soil (Cirilo, 2008). These edaphic-climatic characteristics explain the inequality of water distributions, causing this northeastern region to hold only 3% of the 13.8% of freshwater present in the domains of Brazilian rivers [6].

Based on this assumption, the search for recovery practices that ensure the integrity of these forest formations has been emphasized. The recovery of this can be achieved by soil fertility obtained by restocking with leguminous shrubs-arboreal [7] or by planting fast-growing plant species that can accelerate the secondary succession progressive [8], which should be conducted considering the local flora, and encompass the maximum of species previously present and with the scope of the different ecological groups, forms of dispersion, among others (Attanasio et al., 2006).

This study aimed to monitor the survival or establishment of seedlings in the field through the collection of survival information, in order to verify which group (s) of species (s) is more viable for recovery of riparian forest in areas of Caatinga.

2. MATERIALS AND METHODS

The planting areas are included in the municipality of Patos-PB, coordinates 7° 1 ' 46 " S and 37° 20 ' 44" W and altitude of 242 m. The dominant warm and dry climate according to Koppen (BSh) with average annual temperature of 32°C, relative humidity in annual average is 55%. The average annual rainfall is 500 mm concentrated in three to four months per year, irregularly distributed in time and space with annual insolation that reaches 2.800 hours.

The ciliary plantations were conducted in three rural communities in the months of March and April: Trench (2003 and 2004), Trench I (2004) and Campo Comprido (2005), the banks of the

Trapiá Creek, Espinharas River and Rio da Cruz. It would be interesting to include a map, indicating the área, and places involucrated in the study. 39.0 x 10.5 – 16.5 m, in trench I between 33 x 70 m on both sides of the river and in Campo Comprido the range was 45 x 195 m, on the left bank of the Rio da Cruz.

The recovery of degraded ciliary areas should be conducted considering the local flora, and cover the maximum of species previously present in the area. The species should preferably represent different ecological groups, forms of dispersion (Attanasio et al., 2006).

The appropriate choice of species and their quantities is a decisive factor in the establishment of vegetation and protection against erosive processes, thus being necessary technical knowledge that cover climatic, soil, physiological and environmental factors. It is very important that these represent biodiversity, ecological balance, therefore of the choice of species: pioneers, secondary, and climax.

Table 1. Families and species used in the ciliary plantations in the communities of Trench (Trin), Trench I (Trin) and Campo Comprido (Camp) in the municipality of Patos-PB, in the years 2003 and 2004, 2004 and 2005, respectively

Scientific name	Family	GE	NC
Anadenanthera colubrina (Vell.) Brenan	Fabaceae, Mimosoideae	(P)	Angico
Myracrodruon urundeuva M. Allemão	Anacardiaceae	(C)	Aroeira
Schinopsis brasiliensis Engl.	Anacardiaceae	(P)	Braúna
Triplaris gardneriana Wedd.	Polygonaceae	(S)	Cauaçu
Poincianella pyramidalis (Tul.) L. P. Queiroz	Fabaceae, Cesalpinioideae	(S)	Catingueira
Tabebuia aurea (Silva Manso) Benth. & Hook. f. ex S. Moore	Bignoniaceae	(S)	Craibeira
Poecilanthe falcata (Vell.) Heringer	Fabaceae, Faboideae	(S)	Chorão
Amburana cearensis (Allemão) A. C. Sm.	Fabaceae, Caesalpinioideae	(C)	Cumaru
Pseudobombax marginatum (A. St.-Hil., Juss. & Cambess.) A. Robyns	Malvaceae	(S)	Embiratanha
Lonchocarpus sericeus (Poir.) Kunth ex DC.	Fabaceae, Papilionoideae	-	Ingazeira
Cnidoscolus quercifolius Pohl ex Baill.	Euphorbiaceae	(P)	Favela
Hymenaea courbaril L.	Fabaceae, Caesalpinioideae	(C)	Jatobá
Ziziphus joazeiro Mart.	Rhamnaceae	(C)	Juazeiro
Libidibia ferrea (Mart. ex Tul) L.P. Queiroz	Fabaceae, Caesalpinioideae	(S)	Pau ferro/Jucá
Cereus jamacaru DC.	Cactaceae	-	Mandacaru
Bauhinia cheilantha (Bong.) D. Dietr.	Fabaceae, Caesalpinioideae	(P)	Mororó
Erythrina velutina Jacq.	Fabaceae, Faboideae	(P)	Mulungu
Handroanthus impetiginosus (Mart. ex. DC) Mattos	Bignoniaceae	-	Pau D´arco
Luetzelburgia sp.	Fabaceae, Faboideae	(S)	Pau de serrote
Aspidosperma pyrifolium Mart.	Apocynaceae	(S)	Pereiro
Sapindus saponaria L.	Sapindaceae	(C)	Sabonete
Enterolobium contortisiliquum (Vell.) Morong	Fabaceae, Mimosoideae	(P)	Tamboril
Parkinsonia aculeata L.	Caesalpinioideae,	(P)	Turco
Spondias tuberosa Arruda	Anacardiaceae	-	Umbu

GE – Ecological Group, NC – common name

The species employed in the ciliary plantations and their ecological groups are contained in Table 1, classified according to the proposal contained in APG IV [9] and the synonymy confirmed in the checklist of the association plants of the Northeast.

The seeds were harvested from populations in the municipalities of Malta, Patos, Santa Terezinha, Immaculate, São José do Bonfim, Maturéia, Teixeira and Catingueira, of at least 12 matrices, with a minimum distance of 50 m.

The seedlings were produced in the nursery of the academic unit of forestry engineering, UFCG Campus Patos-PB, in rigid tubete of volume of 250 cm^3, by planting of direct sowing. The substrate consisted of the mixture, in equal proportion, of Plantmax, cattle manure and subsoil (1:1:1). The substrate fertilization consisted of 4.30 Kg of ammonia sulfate, 10.275 Kg of simple superphosphate and 6.850 Kg of potassium chloride, for the volume of 0.7 m^3. Daily irrigation was conducted by electronically controlled spraying. The seedlings remained in the nursery with 50% of shading, before being filled to field were acclimatized until reaching height between 25 – 30 cm.

The pits were prepared with the use of a manual digger, with approximate dimensions of 10 x 30 cm in width and depth, respectively. The spacing adopted in the plantations was 1.5 x 1.5 m in Trench (2003, 2004), and employed 3 x 3m in Trench I (2004) and Campo Comprido (2005) respectively, planted in Is it means quincunce. The pits were fertilized with simple superphosphate, ammonium sulfate and potassium chloride in the amount of 90 g, 90 g and 30 g, respectively. The plantations occurred at the beginning of the rainy season. The seedlings were irrigated from August to October two times a week, with a three-day interval.

Three treatments were tested as a function of seedling disposition according to the ecological group: Treatment 1 (T1)- Pioneer x Secondary x Climax association; Treatment 2 (T2)- only Pioneers, and Treatment 3 (T3)- Secondary x Climax association, in the plantations of 2003 and 2004. In 2005, five treatments were tested: Treatment 1 (T1)- Pioneer x Secondary x Climax association; Treatment 2 (T2)- only pioneers; Treatment 3 (T3)– only alternate pioneers; Treatment 4 (T4)- Secondary x Climax association, and Treatment 5 (T5)- I do not undersand. If it is single how is an association. The total number of seedlings for each ecological group in each treatment was 30, 21 and 8 pioneer, secondary and climax, respectively (T1)30, 21 and 6 (T2) and 29, 19 and 6 (T3), 30,26 and 8 (T4) and 29, 25 and 10 (T5), 64 in each treatment. According the Table 1. There are four species without ecological group.

The survival evaluation was performed in August of each year and in October the final percentage of survival of the species in each site, year and treatment. This was obtained through the presence and absence of them seedlings or young plants at the time of data collection.

3. RESULTS AND DISCUSSION

The results obtained for survival of the species in the areas and years are presented in Table 2. At six months of planting the survival of the species ranged from 48.89 to 97, 21% and 43.33 to 91.66% in Trench 2003 and 2004, respectively. In trench I, the variation was 10.00 to 86.11% and in Campo Comprido from 42.59 to 91.30%.

Regardless of the years and the planting sites, the species that presented survival above 80% were: *Tabebuia aurea* (P), *Handroanthus impetiginosus*, *Triplaris gardneriana* (S), *Enterolobium contortisiliquum* (P), *Parkinsonia aculeata* (P), *Schinopsis brasiliensis* (P), *Cereus jamacaru*, *Myracrodruon urundeuva* (C), *Cnidoscolus quercifolius* (P), *Libidibia ferrea* (S), *Ziziphus joazeiro* (C), *Sapindus saponaria* (C) and *Amburana cearensis* (C).

The survival of the species in the trench community in the year 2003 was superior to the other areas, probably due to the complementary irrigation performed and the use of dead cover at the site of the crowdability, due to decreased evapotranspiration and greater water availability to growing seedlings. It is noteworthy that, in the riparian forest in Cerrado domain in Assis-SP, the survival percentage of I found only 17 from 67 to 100%. However it continuous being an interesting number, because it was higher than 50% [10]. Almeida & Sánchez (2005), considered mortality values of up to 10% in revegetation projects, and found mortality values of 38% in plantations of mined areas in São Paulo. Piña-Rodrigues et al. [11] indicated that mortality values of seedlings after planting up to 20% can be considered normal in projects of revegetation of mined areas.

Table 2. Average survival, per year and place, of the species planted in the communities of Trench (Trin), Trench I (Trin I) and Campo Comprido (CC)-PB in the years 2003, 2004 and 2005, respectively

Species	% Survival			CC/ 2005
	Trin/2003,	2004	Trin I/2004	
Tabebuia aurea	93,33	79,99	72,69	91,30
Bauhinia cheilantha	63,73	73,01	60,97	66,12
Aspidosperma pyrifolium	77,78	71,39	41,67	77,37
Triplaris gardneriana	95,83	84,44	41,11	91,11
Handroanthus impetiginosus	48,89	50,27	65,27	64,44
Erythrina velutina	85,00	43,33	31,44	55,56
Anadenanthera colubrina	56,11	74,01	15,25	82,04
Enterolobium contortisiliquum	93,89	51,70	55,16	83,52
Parkinsonia aculeata	96,66	89,16	73,81	71,57
Schinopsis brasiliensis	66,66	91,66	66,67	-
Amburana cearensis	100,0	91,66	86,11	55,55
Myracrodruon urundeuva	97,21	80,55	83,33	-
Cnidoscolus quercifolius	88,88	81,66	66,67	-
Pseudobombax simplicifolium	77,77	75,00	69,69	57,36
Libidibia ferrea	93,03	54,54	66,67	78,78
Ziziphus joazeiro	-	-	50,00	87,04
Poincianella pyramidalis	-	-	35,00	55,56
Luetzelburgia sp.	-	-	11,11	-
Hymenaea martiana	-	-	10,00	-
Sapindus saponaria	-	-	50,00	92,52
Lonchocarpus sericeus	-	-	-	66,19
Cereus jamacaru	-	-	-	84,63
Poecilanthe sp.	-	-	-	57,41
Spondias tuberosa	-	-	-	48,15
Myracrodruon urundeuva	-	-	-	42,59
Average	**82,32**	**72,82**	**52,65**	**70,44**
Overall survival average			**69,56**	

The percentage of total survival was lower in the trench I (2004) community (52.65%) (Table 2). The treatment with the highest survival percentage was Treatment 1 (T1) in all communities and years (Table 3), consisting of pioneer, secondary and climaxes species. The survival percentages were 88.44 and 64.74% in the trench community (2003 and 2004), 53.10% in Trench I (2004) and 74.89%.. Moraes et al. [12] observed higher growth of secondary species and climax stimulated by the shading of pioneer species. For the authors it is important to note that at the beginning of development, survival rates for the species, because in addition to shading and combating invasive, pioneer species can contribute to a rapid improvement in the quality of the site, due to the return of soil nitrogen, by deposition of leaflets [13].

According to Ganade & Brown [14], the number of positive and negative interactions of plants, animals and microorganisms established in one place, acts on seedlings in the way of establishment.

Table 3. Survival of the species in the different blocks in the communities of Trench (Trin), Trench I (Trin I) and Campo Comprido (CC)-PB in the years 2003, 2004 and 2005

Treatments	Survival percentage			CC
	Trin		Trin I	2005
	2003	2004	2004	
T1	88,44	64,74	53,10	74,89
T2	69,95	67,38	44,99	74,20
T3	74,58	73,72	49,51	75,48
T4	-	-	-	59,35
T5	-	-	-	67,56

4. CONCLUSION

From the above, it is concluded that the pioneer and secondary species had better survival performance in the areas of implantation of the ciliary stands. Probably, because they have the ability to establish themselves in places with adverse conditions, or in environments where the area already has the presence of organic matter, since the original biota was only partially altered. Thus, its use is recommended to recover riparian forest in Caatinga areas.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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