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DIAGNOSIS AND GUIDELINES FOR AFFORESTATION OF THE CENTRAL CAMPUS OF THE FEDERAL UNIVERSITY OF RIO GRANDE DO NORTE – BRAZIL

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ABSTRACT

Urban afforestation is an instrument to improve life quality in cities, by using adequate tree species in urban environments. From this perspective, we carried out a study and diagnosis of the trees planted of the Central Campus of Universidade Federal of Rio Grande do Norte (UFRN) to design a management plan. The 123 hectares of the campus were subdivided into 159 sampling units randomly assigned. We evaluated the health condition and overall condition of individuals with breast height diameter (BHD) greater than 15 cm, including in an index of general appearance. We analyzed 606 trees of 45 species, from which 40% is native species. Ten species predominated accounting for 80% of the total population, and *Cocos nucifera* had the most occurrences. The average index was 4.49, indicating conditions between "good" and "optimal". However, 46.53% showed problems of health condition and 13.53% are not in adequate situations. The UFRN Campus is privileged in afforestation in relation to surrounding urban areas, but it presents a deficit of tree cover, with 0.16 trees *per capita*, mainly composed of exotic species that must to be gradually replaced by native species.

Keywords: Biodiversity; Green Areas; Floristic Survey; Afforestation Plan; Urban Planning.

DIAGNÓSTICO E DIRETRIZES PARA A ARBORIZAÇÃO DO CAMPUS CENTRAL DA UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE

RESUMO

O plano de arborização é um instrumento que atua na melhoria da qualidade de vida nas cidades, adequando espécies arbóreas e meio urbano. A partir dessa perspectiva, realizou-se um levantamento e diagnóstico das árvores do Campus Central da Universidade Federal do Rio Grande do Norte para compor um plano de manejo. A área de 123 hectares do Campus foi subdividida em 159 unidades amostrais tomadas aleatoriamente. Foram avaliados aspectos da fitossanidade e situação dos espécimes com DAP maior que 15 cm, sendo estes enquadrados num índice de aspecto geral. Foram analisadas 606 árvores de 45 espécies, das quais 40% são de origem nativa. Houve predominância de dez espécies, que perfazem 80% da população total, sendo *Cocos nucifera* a mais frequente. O índice médio foi de 4,49, indicando condições das árvores entre “boa” e “ótima”. Entretanto, 46,53% apresentaram problemas fitossanitários e 13,53% não estão em situação adequada. O Campus da UFRN é privilegiado na arborização em relação às áreas urbanas circunvizinhas, entretanto apresenta um déficit de cobertura arbórea, com relação de 0,16 árvores por habitante, formada predominantemente por espécies exóticas que devem ser substituídas gradativamente por nativas locais.

Palavras-chave: Biodiversidade; Áreas Verdes; Levantamento Florístico; Plano de Arborização; Planejamento Urbano.

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INTRODUCTION

Stress conditions imposed by negative impacts of cities generate losses to quality of life of city dwellers. However, there are ways to mitigate these problems, such as environmental legislation and strategies for urban planning (BONAMETTI, 2001). In this context, afforestation is an instrument of urban planning and management to improve improper circumstances provided by the artificiality of urbanized centers.

Afforestation is construed as a set of actions for planning and planting of trees in an urban environment. This, however, underscores the persistence of the natural element within the city structure, which is one of the factors that influences the city's environmental condition, consequently affecting the life quality of the urban population. Because it directly affects urban environmental quality, the planting of trees consists of a corrective action, which is one of the traditional tools employed in urban environmental management (VARGAS and RIBEIRO, 2000).

Afforestation, thus, becomes an essential factor because of the numerous environmental benefits it provides, such as mitigation of thermal discomfort and of the damage caused by water, noise, visual and air pollutions, which are causal factors of physiological and psychological disorders usually associated with urban life (GREY and DENEKE 1978; ROBERTS, 1980; MILANO, 1984; PICOLI and BORGES, 2008).

However, afforestation means more than simply planting trees on city streets and parks. Comprehensive knowledge of the characteristics and environmental conditions is an essential prerequisite for the success of an urban afforestation process, since the multiplicity of factors related to the urban constructions makes afforestation a complex task, requiring good knowledge to successfully accomplish it.

Thus, the choice of a tree species should be based on technical criteria, associating plant requirements with the conditions offered by the planting site, as a means to ensure compatibility between afforestation and construction of urban infrastructure such as street paving and sidewalks, sanitation, electrification and telephone systems (MILANO, 1984; MEDEIROS and DANTAS, 2007).

In wooded areas for leisure, it is common to use landscaping actions where the selection criteria for tree species are based only on scenic beauty and personal preferences, which can result in serious problems, because in this case, there is no concern about the morphological and physiological characteristics of the plant, about requirements of the urban environment and community needs. A good example is the flamboyant (*Delonyx regia* L.), a leguminous tree species that, despite the beauty of its crown and flowers, its roots are tubular and "aggressive", capable of breaking sidewalks and walls (SANTANA and SANTOS, 1999).

Green areas in urban areas consist predominantly of vegetation. Their management aims at preservation of these units in order to provide numerous environmental services to the population (TEIXEIRA, 1999). In addition, green areas help to conserve local biodiversity, provided they are composed of native species, and to improve knowledge and appreciation by the society regarding the biological characteristics of the biome where the city is located.

The quantification and qualification of urban trees are performed by using indicators of demographics, expressed in terms of surface area green/inhabitant (GAI = Green Area Index) (HARDER et al., 2006). Cavalheiro and Nucci (1998) discussed the existence of the index of 12 m^2 of green area/inhabitant considered as ideal and often prescribed by organizations such as UN, WHO or FAO. The authors stated that this index is not known by those institutions and argue that they should refer only to categories of parks in neighborhoods and districts, i.e., public areas that offer outdoor recreation. The Brazilian Society of Urban Afforestation (SBAU) proposed a minimum rate for green areas for public recreation a value of 15 m²/inhabitant (SBAU, 1996).

The Federal University of Rio Grande do Norte (UFRN), in the city of Natal – Rio Grande do Norte state – Brazil – , due to its egregious geographical space, diversity of services and infrastructure and its high number of users,

resembles a small town structurally and administratively, including its environmental problems. As the core generator of knowledge, the university has the responsibility to provide examples of how a city should be organized and managed according to its reality, offering viable solutions to problems commonly faced by the community and public administration.

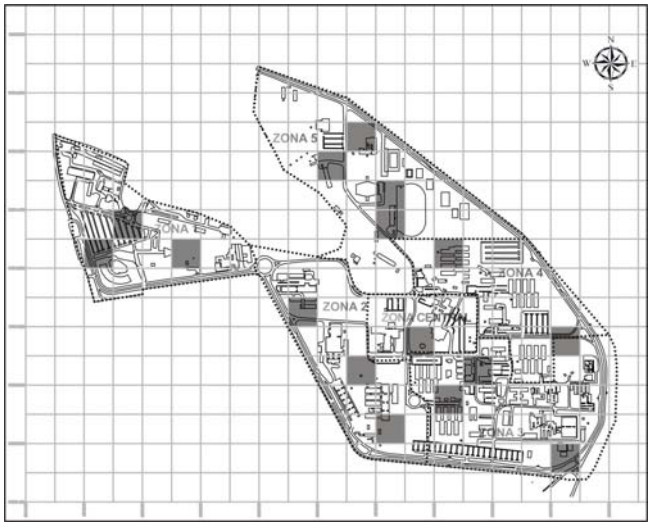
Currently UFRN does not have an afforestation plan, consisting only of random actions of tree planting. Despite the undeniable benefits of afforestation, it can present significant problems, such as allocation of trees in inadequate sites, excessive use the same tree species and the use of invasive species. Thus, an afforestation plan on campus is essential to manage the actions of planting and preservation of trees to avoid future problems, and ensure the inherent benefits to the environment.

The present study analyzed afforestation aspects of the Central Campus of UFRN, aiming to develop an information basis that will serve as a tool for the management plan and environmental management of the tree specimens.

MATERIALS AND METHODS

The Central Campus of UFRN covers 123 hectares and is located in the southern sector of the municipality of Natal – Rio Grande do Norte state – Brazil –, surrounded by an urban area and bordering east the Parque Estadual Dunas de Natal "Jornalista Luiz Maria Alves". Although it does not have a fixed population in its facilities, the university community, in 2009, consisted of about 30,000 people, comprised of students, workers and outsourced employees. This number tends to grow, reaching about 45,000 people, with the creation of new courses and the hiring of new workers due to the implementation of the project Reestruturação e Expansão das Universidades Federais (REUNI) (Restructuring and Expansion Project of Brazilian Federal Universities). The campus, unlike a city or neighborhood, is not subdivided into lots, but in six zones (1, 2, 3, 4, 5 and Central), which will be used in this study (Figure 1). Pedestrians use all areas of the campus, therefore, the entire space between buildings is susceptible to the management of green areas.

Figure 1. Map of the Central Campus of UFRN, divided into quadrants with 10.000m^2 of floor area. Dotted lines indicate the boundaries of each zone and the quadrants with crosshatched lines indicate the sample units



The inventory was conducted by random sampling as recommended by Grey and Deneke (1978), as follows:

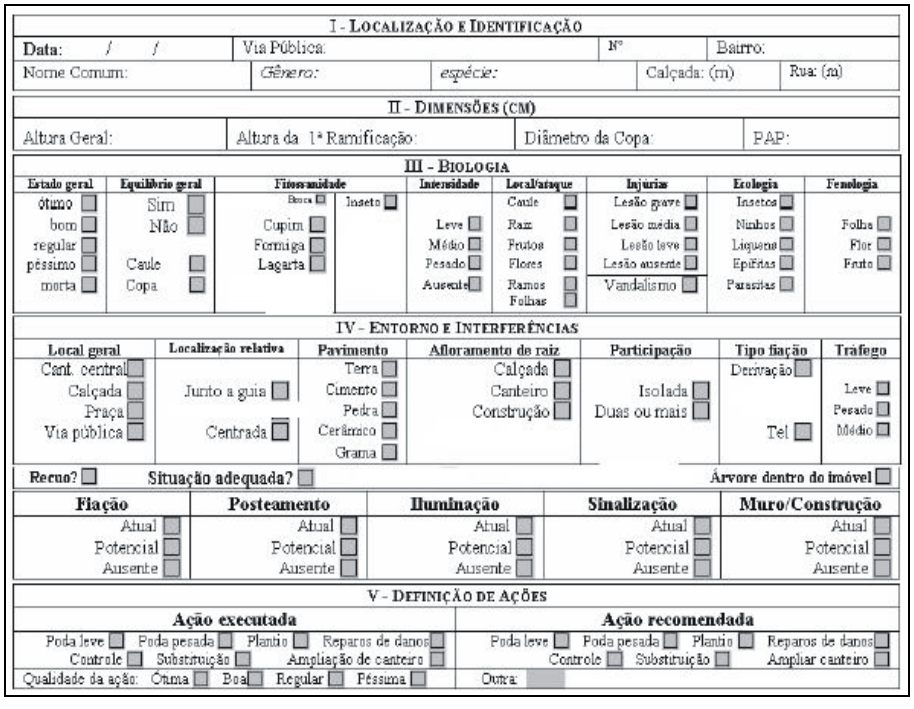
- Selection and subdivision of the sample area: based on the official map of the Central Campus, the area was divided into quadrants of 100 x 100 m, totaling 159 sampling units (Figure 1). The sampling of each zone was performed using the equivalent of 10% of the total samples, obtaining 16 quadrants (equivalent to 16 acres), which represent 13% of the total area of the campus.
- Choice of sampling units: to determine which sample units would be analyzed, was assigned a number to each unit, which were randomly selected through the *Random Number Generator Pro software* (SEGOBIT SOFTWARE®, 2000-2009).
- Selection of trees to be studied: we analyzed all representatives of tree species with BHD greater than 15 cm.

Data were collected based on a tree inventory form (Figure 2) proposed by Silva Filho (2002). Trees are classified regarding their general appearance, defined as "optimal", "good", "regular", "bad" or "dead", corresponding to the indices 5, 4, 3, 2 and 1, respectively. This classification was based on the integrity of the tree crown (leafy, leafy with small faults, thin, thin with damaged branches, dead). To obtain a general index, we used the following formula:

$$In = \frac{\prod(n_x * x)}{y}$$

Where: *In* is the general index (average); n_x is the total number of individuals in the classification "x"; *x* is the respective number/weight of the classification and *y* is the total number of classifications.

Figure 2. Spreadsheet of the fieldwork for manual records



I - LOCALIZAÇÃO E IDENTIFICAÇÃO

Data: / / | Via Pública: | Nº | Bairro:

Nome Comum: | Gênero: | espécie: | Calçada: (m) | Rua: (m)

II - DIMENSÕES (CM)

Altura Geral: | Altura da 1ª Ramificação: | Diâmetro da Copa: | PAP:

III - BIOLOGIA

Estado geral	Equilíbrio geral	Fitossanidade		Intensidade	Local/ataque	Injúrias	Ecologia	Fenologia
ótimo	Sim	Broca	Inseto		Caule	Lesão grave	Insetos	
bom	Não	Cupim		Leve	Raiz	Lesão média	Ninhos	Folha
regular		Formiga		Médio	Frutos	Lesão leve	Líquens	Flor
péssimo	Caule	Lagarta		Pesado	Flores	Lesão ausente	Epífitas	Fruto
morta	Copa			Ausente	Ramos	Vandalismo	Parasitas	
					Folhas			

IV - ENTORNO E INTERFERÊNCIAS

Local geral	Localização relativa	Pavimento	Afloramento de raiz	Participação	Tipo fiação	Tráfego
Cant. central		Terra	Calçada		Derivação	
Calçada	Junto a guia	Cimento	Canteiro	Isolada		Leve
Praça		Pedra	Construção	Duas ou mais		Pesado
Via pública	Centrada	Cerâmico			Tel	Médio
		Grama				

Recuo? Situação adequada? Árvore dentro do imóvel

Fiação	Posteamento	Iluminação	Sinalização	Muro/Construção
Atual	Atual	Atual	Atual	Atual
Potencial	Potencial	Potencial	Potencial	Potencial
Ausente	Ausente	Ausente	Ausente	Ausente

V - DEFINIÇÃO DE AÇÕES

Ação executada	Ação recomendada
Poda leve, Poda pesada, Plantio, Reparos de danos	Poda leve, Poda pesada, Plantio, Reparos de danos
Controle, Substituição, Ampliação de canteiro	Controle, Substituição, Ampliar canteiro
Qualidade da ação: Ótima, Boa, Regular, Péssima	Outra:

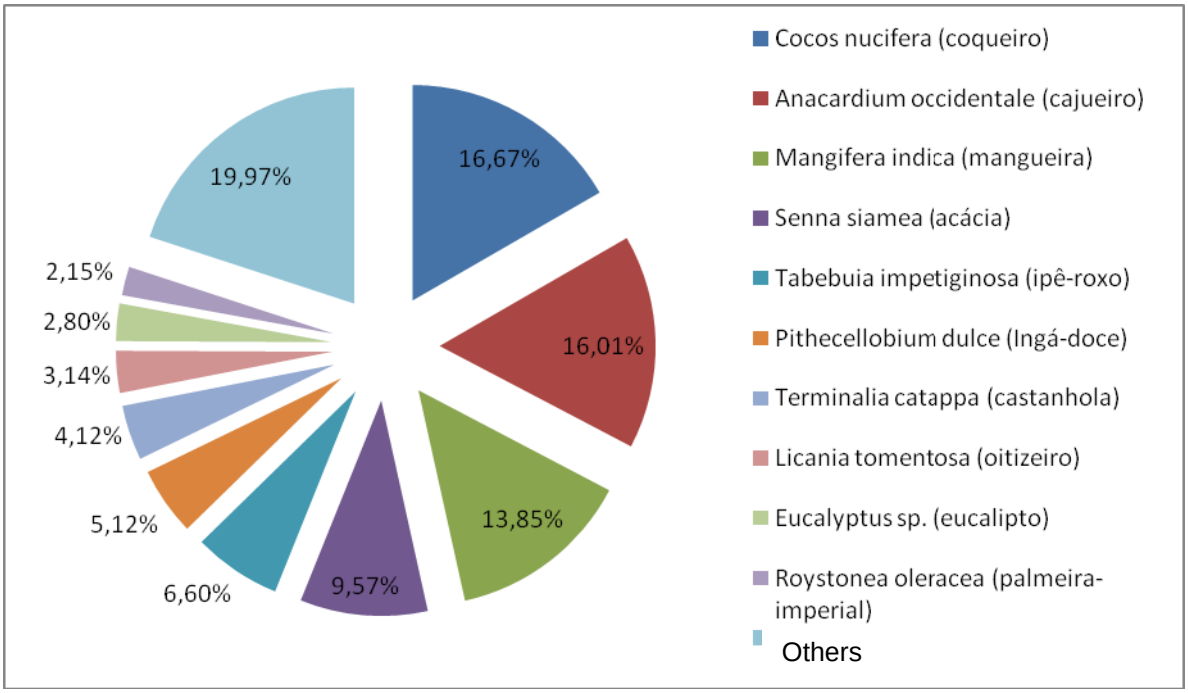
Source: SILVA FILHO, 2002

RESULTS AND DISCUSSIONS

The Central Campus of UFRN presents itself as a whole area without any kind of internal division, where all spaces between buildings are open and accessible. This feature allows the deployment and availability of a wide variety of green spaces, such as central plant beds, forests, parks, squares, gardens, protected areas, not-built-up areas and open areas with a predominance of grasses and herbaceous species. In this inventory, we analyzed 606 trees of 45 species, being only 40% native and 60% exotic species. The plants were identified according to Lorenzi (2002a, 2002b, 2003).

In terms of occurrences, exotic trees account for 50.5% and native 49.5% of the trees. Regardless of geographical origin, we observed a predominance of ten tree species, accounting for approximately 80% of the tree population of the campus (Figure 3). However, this representation is highly heterogeneous, since the most frequent (*Cocos nucifera* L.) corresponds to 16.67% of trees, while the tenth most planted (*Roystonea oleracea* Jacq.) accounts for only 2.15% of total trees of the campus (Figure 3). This may be an indicative of lack of planning in the afforestation process.

Figure 3. Occurrences of the ten tree species most found at the Central Campus of UFRN



Calculating the ratio between the number of trees and people that frequent the campus, we obtain an average of 0.16 trees *per capita*. Although this rate is two times higher than that found by Medeiros (2007), who inventoried urban trees of Campina Grande city – Paraíba state – Brazil –, it is still considered low, since this value does not reach the GAI recommended by SBAU.

Many studies on trees survey and floristic diagnosis, such as those of Teixeira (1999) and Lombardi and Mitchell (2003), relied on *in loco* analysis and on records of existing afforestation plans. UFRN has no records as to whether the trees belonged to some sort of afforestation program.

The estimated average level for general appearance was 4.49, and the condition of the trees on campus was expected to be between "good" and "optimal". This index is higher than that found by Milano (1984) in Curitiba city – Paraná state – Brazil –, however this evaluation is

subjective. The percentages recorded were 59.74% of trees "excellent"; 31.52%, "good"; 6.77%; "regular", 1.65%; "bad", and 0.17%,"dead".

Regarding plant health, 15.18% was infested by termites (Termitidae); 4.79% parasitized by homopterans; 0.66% infested by hemipterans; 5.94% by lianas; 1.82% had perforations in the leaves or trunk by insect larvae (borer), and 28.22% had some type of physical damage (Table 1).

Table 1. Occurrence of trees with health or physical problems at the Central Campus of UFRN, by species.

Scientific name	Popular name	Qty.	Termite	Homopterans	Lianas	Borer	Light damage	Serious damage
Cocos nucifera L.	Coqueiro	101	-	-	-	-	-	-
Anacardium occidentale L.	Cajueiro	97	76.09%	-	2.78%	27.27%	24.05%	33.33%
Mangifera indica L.	Mangueira	84	11.96%	-	5.56%	-	3.16%	-
Senna siamea H. S. Irwin e R. C. Barneby	Acácia	58	-	58.62%	22.22%	-	25.95%	-
Tabebuia impetiginosa Standl.	Ipê roxo	40	-	-	5.56%	-	-	-
Pithecellobium dulce Benth.	Ingá doce	31	3.26%	-	2.78%	-	10.13%	11.11%
Terminalia catappa L.	Castanhola	25	6.52%	-	52.78%	-	11.39%	22.22%
Licania tomentosa Fritsch	Oitizeiro	19	-	-	-	-	1.90%	-
Eucalyptus sp. L. Hér.	Eucalipto	17	-	-	-	-	10.76%	-
Roystonea oleracea Jacq	Palmeira imperial	13	-	-	-	-	-	-

Species with the most significant contribution for the tree population, such as *Anacardium occidentale* L. (16.01%), *Senna siamea* H. S. Irwin and R. C. Barneby (9.57%) and *Terminalia catappa* L. (4.13%) account for more than 50% of their respective populations with phytosanitary problems. This rate shows the susceptibility of these species to common pests of the region, corroborating Milano (1984).

In relation to physical damage, the high percentage found in *Anacardium occidentale* (57.38%), *Terminalia catappa* (33.61%) and *Senna siamea* (25.95%) is mostly due to the use of inappropriate pruning techniques and to the age of trees. In the total sample, 28.22% showed some type of damage.

In 51% of the cases, we observed both physical damages and disease problems, such as termite infestation, which reveals the use of inadequate pruning techniques that favor parasitism. However, it is essential to carry out further studies to support such conclusions.

In the sampled population, 46.53% of the trees presented problems, requiring some type of treatment, and 13.53% was not in an adequate condition, which can cause serious accidents or damage to local infrastructure. Regarding the need for treatment, most cases were related to physical and sanitary conditions. Table 2 shows the percentage of need for treatments for each species.

Table 2. Percentage of trees that need special treatment at the UFRN Central Campus, by species

Scientific name	Popular Name	Treatment	Pest control	Replacement
Cocos nucifera L.	Coqueiro	-	-	45.34%
Anacardium occidentale L.	Cajueiro	19.78%	46.15%	-
Mangifera indica L.	Mangueira	4.40%	2.56%	-
Senna siamea H. S. Irwin e R. C. Barneby	Acácia	31.87%	11.11%	-
Tabebuia impetiginosa Standl.	Ipê roxo	5.49%	1.71%	-
Pithecellobium dulce Benth.	Ingá doce	14.29%	3.42%	-
Terminalia catappa L.	Castanhola	1.10%	19.66%	-
Licania tomentosa Fritsch	Oitizeiro	2.20%	-	-
Eucalyptus sp. L. Hér	Eucalipto	-	-	23.29%
Roystonea oleracea Jacq.	Palmeira imperial	-	-	-

Maintenance actions of the trees mostly comprise inappropriate pruning practices, causing necrosis of branches, providing an abject appearance to the tree. This is in line with the reasons mentioned by Teixeira (1999), however, we noted that actions of vandalism, damages to sidewalks and root outcropping in the total population sampled occurred at very low frequency, which disagreed with the results obtained by Milano (1984) and Santana and Santos (1999). The low occurrence of vandalism may be explained by the age and educational level of the population on campus.

The need for pest control occurred in 28.38% of the population, indicating the vulnerability of the tree species to the attack of parasites. Thus, it is essential to have phytosanitary monitoring of plant species to be used in afforestation.

The need for tree replacement is mainly due to inappropriate use of species according to local requirements, such as the planting of large-sized trees under high voltage electrical grids and fruit trees in sites with heavy pedestrian movements and car parking. The same problem is observed in Brazilian cities like Curitiba – Paraná state (MILANO, 1984), Feira de Santana – Bahia state (SANTANA and SANTOS, 1999), Santa Maria – Rio Grande do Sul state (TEIXEIRA, 1999) and Campina Grande – Paraíba state (MEDEIROS and DANTAS, 2007).

This problem is solved by gradually replacing the existing trees by other species that have morphological characteristics appropriate to these situations. This misuse is common on campuses due to the intended use, such as preference for fruit trees of great acceptance or beauty, which were planted without a thorough planning of green areas of the university campus.

Proposed guidelines for the management of urban trees on the Central Campus of UFRN

The development of tree management requires professional expertise and broad technical knowledge associated with standards for procedures. This management allows to mitigate the negative aspects in cities, both for landscaping and environmental issues, and provides improvements in life quality for their residents, consisting, thus, of an important instrument for the management of the environment (VARGAS and RIBEIRO, 2000).

The choice of species to be used in afforestation requires complementary actions and essential information related to trees adaptability to urban environments, such as easiness of cultivation, growth rate, susceptibility to pests and diseases, crown adequacy and fruit weight. However, for the reality of the Central Campus of UFRN, the use of

exotic species, although compatible with the criteria mentioned, should be restricted due to their predominance and abundance over native species.

Another concern related to the cultivation of exotic species at the Central Campus is its proximity to a Conservation Unit (Dunas de Natal State Park), which facilitates the spread of these species across to that area by natural spread. Species such as *Azadirachta indica*, *Eucalyptus sp*., *Leucaena leucocephala*) and *Prosopis juliflora* are considered invasive species (INSTITUTO HÓRUS, 2009), i.e., exotic species capable of reproducing in environments other than their native environments. These species are found on campus and have the capacity to disperse their seeds and colonize environments similar to that found in the Dunas de Natal State Park.

Unlike exotic species, the cultivation of native species offers more pest-resistant trees and serves not only as a factor to maintain the local flora, but also as a facilitator for the fauna movement between the Central Campus and Dunas de Natal State Park, because the trees provide shelter, food and safer routes in the urban environment. Thus, the tree species used should produce fruits and seeds in different seasons, to provide continuous supply of food in these tree corridors.

We conducted a survey of native species with morphological characteristics compatible with the existing green spaces on campus, such as plant beds, parks, gardens and in the woods. We considered 33 species occurring in the biomes of Caatinga and Atlantic Forest of Rio Grande do Norte state (Table 3).

Table 3. List of tree species found in Caatinga and Atlantic Forest of Rio Grande do Norte state with potential for urban afforestation. The characteristics studied were persistence of leaves (D = deciduous; P = Evergreen; S = Semideciduous), fruit weight (L = Light, P = Heavy), crown adequacy (Ar = Rounded; Al = Oblong; D = Disorderly; G = Globular; P = Palm) and maximum height (in meters)

Scientific name	**Popular name**	**Leaf**	**Fruit**	**Crown**	**Height**
Allophylus edulis (A.St.-Hil) Radlk.	Cumichá-branco	S	L	G	6-10
Anadenanthera macrocarpa (Benth.) Brenan	Angico	D	L	G	13-20
Apuleia leiocarpa (Vog.) J.F.Macbr.	Jitaí	D	L	Ar	25-35
Aspidosperma pyrifolium Mart.	Tipiá	D	L	G	7-8
Bowdichia virgilioides Kunth	Sucupira	D	L	G	8-16
Brosimum guianense (Aubl.) Huber	Quiri	S	L	Al	10-30
Caesalpinia echinata Lam.	Pau-brasil	S	L	Ar	8-12
Casearia sylvestris Sw	Ramo de carne	P	L	Ar	4-6
Cedrela odorata L.	Cedro	D	L	Ar	25-35
Copaifera cearensis Huber ex Ducke	Pau-d'óleo	S	L	G	10-15
Copernicia prunifera (Miller) H. E. Moore	Carnaúba	P	L	P	7-10
Cordia superba Cham.	Grão-de-galo	S	L	G	7-10
Cupania oblongifolia Mart.	Camboatã	P	L	Al	7-18
Curatella americana L.	Lixeira	S	L	G	6-10
Ficus catappafolia L.	Gameleira	P	L	G	8-16
Hancornia speciosa Gomes	Mangabeira	S	L	Ar	5-7
Hirtella ciliata Mart. e Zucc.	Campineiro	S	L	G	8-12
Hisbiscus pernambucensis Arruda	Algodão-da-praia	P	L	G	3-6
Hymenaea courbaril L.	Jatobá	S	P	Ar	15-20
Inga cylindrica (Vell.) Mart.	Ingá-tripa	S	L	G	8-18
Lecythis pisonis Cambess.	Sapucaia	D	P	Ar	20-30
Piptadenia moniliformis Benth.	Jurema-preta	D	L	Ar	4-9
*Pouteria grandi*flora (DC.) Baehni	Goiti-trubá	P	P	Al	6-14
Protium heptaphyllum (Aubl.) Marchand	Amescla-decheiro	P	L	G	10-20
Senna spectabilis H.S.Irwin e Barneby	São joão	D	L	Ar	6-9
Spondias tuberosa Arruda	Umbú	D	L	D	4-7
Syagrus oleracea (Mart.) Becc.	Catolé	P	P	P	10-20
Tabebuia aurea (Silva Manso) Benth. e Hook	Ipê-amarelo	S	L	G	12-20

Tabebuia impetiginosa (Mart. Ex DC.) Standl.	Ipê-roxo	D	L	G	8-12
Tabebuia roseo-alba (Ridl.) Sandw.	Peroba	P	L	G	7-16
Tapirira guianensis Aubl.	Cupiúba	P	L	G	8-14
Trema micrantha (L.) Blume	Grandiúva	S	L	G	5-12
Zizyphus joazeiro Mart.	Juazeiro	P	L	G	5-10

Based on this proposal of species, the planting and cultivation of individuals are facilitated by tree adaptability to climate and soil conditions. However, the planting should be carried out preferably during the rainy season in order to have success in the seedlings establishment and to decrease the cost with irrigation and services. Concurrently, the phytosanitary control, given the occurrence of infestations and diseases, should be applied continuously. When phytosanitary problems occur, solutions should follow a technical nature and not include the use of chemicals or the introduction of competing species or pest predators.

Table 3 shows trees with features that would meet the requirements for the local studied. The following species are examples of trees that can be used under high-voltage networks (at the Central Campus the standard height is 9.3 meters): *Aspidosperma pyrifolium*, *Casearia sylvestris*, *Hancornia speciosa*, *Hisbiscus pernambucensis* and *Spondias tuberosa*.

In parking lots, to ensure a shady and airy environment offering conditions that maintain the integrity of cars, it is recommended the use of tall trees that have frond crowns of evergreen leaves and light fruits that do not cause dirt or damage private property (motor vehicles). Some examples of species for these conditions are *Caesalpinia echinata*, *Copaifera cearensis*, *Cupania oblongifolia* and *Hirtella ciliata*.

The plants to be used in central plant beds must be large to provide shade to the streets and not obstruct the driver's vision in traffic circles, as it may occur with the use of shrub species. Columnar species, such as native palm trees, are also indicated for this type of green spaces, especially when the median is narrow.

Regarding the abundance of a species in an afforestation system, it is not recommended that a species represent more than 15% of the total population of an area, because besides issues of monoculture, they can facilitate the spread of specific diseases among individuals of the majority species and reduce local biodiversity. Therefore, an afforestation plan must use at least ten different species of trees in its inventory.

Although an afforestation plan aims at planting trees, the use of a compensation process, which consists of mitigating negative aspects caused by anthropogenic activities, must be included and carried out through the replanting of trees, which would be actions apart from the programmed activities of tree planting.

The implementation of these guidelines requires special infrastructure, permanently managed by the institution, allowing the production of its own seedlings according to the needs of the existing flora. However, because it is a highly complex activity, the role of a multidisciplinary team comprised of agronomists, architects, biologists and general service staff, is essential for the success of an afforestation plan.

CONCLUSIONS

Although the Central Campus of the UFRN is privileged by tree planting compared to surrounding urban areas, it is concluded that there is still a great lack of tree cover, with only 0.16 trees *per capita*. In addition, more than half of this cover is represented by exotic species, which can be more susceptible to parasites and their dispersion

is facilitated as they compete with native species for resources, undermining the local biodiversity in the long-term.

A better selection of tree species and their representation in the afforestation process provide lower levels of infestation, lower need for phytosanitary treatments and tree replacements, resulting in lower maintenance costs and improved environmental quality in public places. Therefore, we conclude that it is necessary to design a management system for urban afforestation of the Central Campus of the UFRN.

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