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Characterization of the afforestation present in two gardens in Nova Esperança, PR

M. Sorace, A. E. A. Ecker, L. H. Kitakawa, M. G. Balan, A. B. P. Suzuki, R. S. Uhdre

Universidade Estadual de Maringá - Campus Umuarama
Centro Universitário Ingá
Universidade Estadual de Londrina

Author for correspondence: mauren_band@hotmail.com

Abstract. The objective of this study was to evaluate tree arborization in the parameters of tree species, origin, planting site, height of the first bifurcation in the Santo Antonio and Santa Cruz gardens in the city of Nova Esperança, State of Paraná. The afforestation of public roads is one of the elements of the urban structure, characterizing the spaces of the city through their forms, colors and grouping mode and playing important roles both for cities and for their inhabitants: they help control climate and pollution, in hydrological control, in water conservation, in erosion reduction, in energy saving, in the well-being of the inhabitants, among other benefits. Significant reduction of the presence of Sipipirunas in the study areas, contemplating the idea of frequency of less than 15% of each species. Positive aspect observed was the use of native species corroborating with the environmental recommendations preserving the flora present in the biomes of the State and country. In the case of damages caused by root system, the low occurrence in the study areas was verified. It is suggested to format the law indicating the height of the first bifurcation for the transportation of arboreal specimens in public roads, since there were significant differences when compared to the Santo Antonio and Santa Cruz gardens.
Keywords: Tree specimens, public roads, environment.

Introduction

The afforestation of public roads is one of the elements of the urban structure, characterizing the spaces of the city through their forms, colors and grouping and playing important roles both for cities and for their inhabitants: they help control climate and pollution, in hydrological control, in water conservation, in erosion reduction, in energy saving, in the well-being of the inhabitants, among other benefits (Shams et al., 2009; Romani et al., 2012; Freitas et al., 2015). According to Lilly et al., (1999) the identification of the species becomes paramount for the accomplishment of forest inventory in which the knowledge of different parameters is sought.

The phenomenon of urbanization is growing and global, and with increasing population the spaces and places for activities have also undergone transformations in both the natural and built environment. These new transformations have caused significant climate change, with life of the populations (Labaki et al., 2011, Oliveira et al., 2013).

According to Kramer and Krupek (2012) cities should invest in the planning of afforestation with programs of studies on the urban space for the elaboration of a plan of afforestation that seeks to value the landscape and ecological aspects, prioritizing the use of native species with potential for this type of use. For the benefit of the population to be used by the population, the planning and efficient management of these public trees is essential in order to avoid inconveniences such as pruning needs, falls, cracks in sidewalks, implantation of unsuitable species, among other problems. frequent and require lots of maintenance and well-planned care (Sampaio et al., 2011). Most of the municipalities in the country do not have or do not follow any previous planning for the execution of urban afforestation. However, in order for urban afforestation to really play its full role, it is necessary to have adequate planning and implementation, with subsequent maintenance. The creation of vegetated spaces in the cities is related not only to the quality of life, but also to the beautification and aesthetics. It can be observed that Brazilian cities like Curitiba-PR

and Goiânia-GO have expanded their area the creation of areas such as parks, squares and gardens, central in the avenues with vegetation (Oliveira; Alves, 2013).

According to Labaki et al. (2011), trees are responsible for the decrease of a large part of the incident radiation, preventing it from reaching buildings or soil, reducing the temperature and providing passive cooling in the buildings, as well as reducing the temperature and surface heating. In the plants the leaves evaporate about 97% of water through the perspiration, contributing to decrease of the heat in the plant and reducing temperature of the environment (Holbrook, 2010).

The low diversity of species used in the planning of the arborization of squares and urban sites, despite presenting enormous variety of the native flora of each region to be used due to the tropical climate of each city (Gonçalves & Paiva, 2004; Silva Filho & Bortoleto, 2005). However, studies carried out by Gonçalves and Paiva (2004) present low species diversity in the urban arborization resulting from the preference for the use of exotic species, from other regions of the country as well as foreign, that probably occurs due to the little ecological knowledge of the native species and / or the choice of species traditionally used in the afforestation of other places. The use of a few species per unit area also promotes floristic homogeneity, which becomes a major risk for the proliferation of pests and diseases in urban vegetation (Souza et al., 2011).

In order to assess the real situation of the urban afforestation of a municipality, it is necessary to carry out the arboreal census, that is, firstly to make a quantitative survey of the tree species and also a qualitative survey. The general purpose of the inventory is to know the arboreal patrimony of an area or locality and, for this purpose, it is essential to plan and manage the afforestation, providing information about the need for pruning, phytosanitary treatments or removal and planting, as well as As to define priorities for interventions (MELO et al., 2007).

The objective of this study was to evaluate tree arborization in the parameters of tree species, origin, planting site, height of the first bifurcation in the Santo Antônio and Santa Cruz gardens in the city of Nova Esperança, State of Paraná.

Methods

The study area of the present study consists of the municipality of Nova Esperança located in the northwest of the State of Paraná, Brazil. The city is located between the latitude of 23º11'02 "and longitude 52º 12'18", having altitude near 550 m. According to the Brazilian Institute of Geography and Statistics (IBGE, 2010) at the time the city had an estimated population of 26,532 in habitants, in an area of 401.59 km², thus giving the city a population density of 66.9 hab km².

According to Maack (1981) the predominance is red latosol, red podzolic, shallow soils, hydromorphic soils, quartz sands and colluvial soils. The city is inserted in the Third Paranaense Plateau, that is, the Guarapuava Plateau, to be more exact in the Sub Plateau of Apucarana. The city of Nova Esperança is among the important watersheds of Parana: Baixo Ivaí Basin; Paranapanema Basin IV and Pirapó Hydrographic Unit. Albertin et al. (2011), report that the municipality presents summers characterized by abundant rains and excessively humid season, but in winter the situation alternates for absence of rains and consequently drier. According to data from the ITCG (2011), annual rainfall is 1200 to 1500 mm, with rainy months from october to January. During the period from may to october 2016, evaluations were carried out in the study areas, verifying in situ the parameters conferred to the present study. For the accomplishment of the activities to the field was acquired in the city hall updated maps of the districts Santo Antonio and Santa Cruz gardens, being the same ones given in scale 1:50 to the identification of the studied area. The evaluation was made based on the determination of the tree species. For the classification of botanical families, the APG III system was adopted (2009).

For the tree species quantification, the tree census was used and for the parameters of qualification, a set of methods proposed by the following authors was used, Albertin et al. (2011) and Rodolfo Junior et al. (2008). The root problems caused by tree species were evaluated under external conditions, separated into four categories: I - subterranean, that is, root is not exposed; II - superficial, that is, the root is pointed at the surface of the soil; III - superficial, with cracks in the sidewalk, from low to medium degree, this means that, root is exposed on the surface and shows signs of break in the walk or the street; IV - superficial with cracks in the high grade footpath, where, the root when emerging on the surface breaks the surface structure of the walk and / or street.

These evaluations were done in a visual way, with subsequent consultation for identification in specialized bibliographies. To evaluate the chest height diameter (DAP), a Vonder 3000 mm tape measure was used at a standard height from the soil level of 1300 mm to evaluate the height of the first branch (APB), it was used of a tape of 5 m, Tramontina brand, and for heights greater than 5 m the value of the height was estimated visually. For the collection of data the following worksheet was prepared, to better organize the information. The evaluation used to identify the species was: leaf, flower and fruit types.

Results and discussions

During the evaluation months, information was tabulated and evaluated in order to bring the current reality of the studied gardens closer together and to diagnose possible improvements. Initially, there were 613 arboreal specimens in the Santo Antônio and Los Angeles gardens, with 22 different species.

Based on the survey of the gardens under study when compared to the census carried out in the municipality in August 2009, there are 22 present species present compared to the 74 species found at the time.

Corroborating with the arboreal specimens present in the census, the majority of these species were nowadays: *Caesalpinia peltophoroides*, *Licania tomentosa*, *Tabebuia impetiginosa* and *Pachira aquatica*, that is, five of the same species with the highest frequency. In terms of quantitative, the neighborhoods studied have Oitis (25%), Aroeiras parsley (13.4%), Mongubas (9.7%), Ipês (5.6%) and Sibipirunas (2.5%). According to work done by Redin et al. (2010) recommend that for aesthetic and phytosanitary reasons the frequency of a single species does not exceed 15%, since the number of species to be used and the proportionality of use of species in relation to the total number of trees to be planted.

However, the species *Licania tomentosa* (Oiti) presents outside the standards for urban afforestation, considering the proposal of Gray and Deneke (1978) that suggest a frequency between 10 and 15% of the same tree species. The number of oitis is high, which shows us that the floristic composition of these neighborhoods was mainly focused on this species. This proposal has as main objective to avoid that the floristic composition of the municipalities undergoes some type of eradication, that can happen so much by outbreak of plagues and / or diseases.

A common problem found in the afforestation of the raised gardens in Nova Esperança - PR was a large quantity of *Pachira aquatica* (Monguba), *Licania tomentosa* (Oiti) and *Mangifera indica* (Mangueira), besides having large fruits possess a large size, that is, above of 10 m of height, causing constant interferences in the electrical and telephone wiring. Similar results in relation to the presence of these trees in the survey of the arborization of squares in Cuiabá was verified by Oliveira et al. (2013), finding about 56% of oitizeiros and 21% of hoses.

Qualitative survey of Los Angeles Garden

During the evaluation, the identification of 16 tree species distributed throughout the tree was analyzed. In the study area, the frequencies of tree species were *Licania tomentosa* (43%), *Caesalpinia peltophoroides* (38%), *Schinus molle* (4.3%), *Pachira aquatic* (4%), *Tabebuia impetiginosa* (4%), *Tibouchina granulosa* (1.8%), *Mangifera indica* (1.4%), *Ficus auriculata* (1.1%) and other species with less than 1% each.

On the origin of the tree species, of the 4.35% Exotics the *Mangifera indica* is the one that possesses in greater quantity, in percentage data it represents 33,3% of all exotics trees, followed by *Ficus auriculata* with 25%, *Callistemon* spp. with 16.6% and the others with 8.3% (*Delonix regia*, *Ligustrum lucidume*, *Eriobotrya japonica*). Being that 95.6% are natives species.

Silva et al. (2017) made a diagnosis of the arboreal vegetation of Praça dos Açorianos, located in the city of Porto Alegre, RS, and obtained results in the identification of the species that were around 64% native species and prevailed in relation to exotic species (36%). The most abundant species were *Syagrus romanzofianna* (native) and *Tipuana tipu* (exotic).

Family of tree species

The 16 species identified in the garden belong to 11 distinct families, the family Anacardiaceae with two species (*Mangifera indica* and *Schinus molle*), the family Bignoniaceae is represented by *Tabebuia impetiginosa*.

The family Bombacaceae (4%) is represented by *Pachira aquatica*, the family of Chrysobalanaceae (42%) is represented by *Licania tomentosa*, while the Fabaceae family (38%) is represented by *Caesalpinia peltophoroides*, *Caesalpiniae chinata*, *Delonix regiaa*, the family Lauraceae (0.5%) is represented by *Ocotea pulchella*, the family Melastomataceae (1.8%) is represented in the neighborhood by *Tibouchina granulosa*, the family Moraceae (1.1%) is represented by *Ficus auriculata*, the family of Myrtaceae (1.4%) is represented by three tree species (*Callistemon* spp., *Eugenia uniflorae*, *Psidium guajava*), whereas the Oleraceae family is represented by the *Ligustrum lucidum* and the Rosaceae family is represented by *Eriobotrya japonica*.

Planting site and root system

The parameters evaluated were qualitative and quantitative were planting site and root system, however, meanings were initially created where the (I) means that the species was inserted between 0.5 and 1.0 m of the yarn, (II) inserted between 1.01 and 1.5 m, (III) inserted from 1.51 to 2.0 m and (IV) above 2.01 m.

For the root system, a similar evaluation system was created with the same indicators (I, II, III and IV), where (I) means that the root system is underground, (II) the superficial root system, that is, above (III) superficial root system with cracks in the sidewalk, from low to medium degree and (IV) superficial root system with cracks in the high grade pavement. Both items are shown below in Figures 1 and 2 respectively.

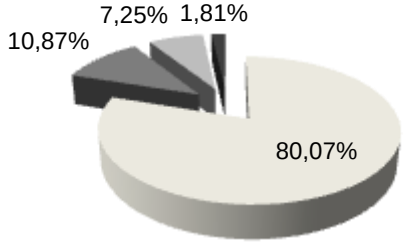

Figure 1 - Planting location expressed in (%) identified in Los Angeles garden. Source: The author

The species that presented the highest percentage of 0.5 to 1 m of the middle (I) were *Licania tomentosa* with 45.7% and *Caesalpinia peltophoroides* with 36.2%, already planted from 1.01 to 1.5 m (II) were *Caesalpinia peltophoroides* (53.3%) and *Licania tomentosa* (26.6%). The planted from 1.51 to 2 m (III) most common were *Caesalpinia peltophoroides* (40%) and *Licania tomentosa* (35%). Planted at more than 2.01 m from the middle (IV) 80% are *Caesalpinia peltophoroides* and 20% *Mangifera indica*.

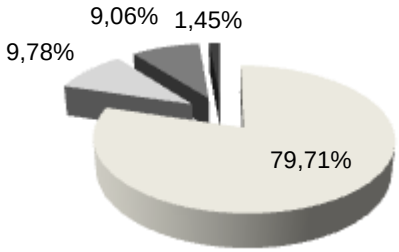

Figure 2 - Expressed root system (%) identified in Los Angeles garden. Source: The author.

Caesalpinia peltophoroides is present in all the trees with the greatest root system problem, as it is a large species in the neighborhood, and 3.8% of the trees present a superficial root system with high grade cracks (IV). And 19% presents a superficial root system with cracks in the pavement, from low to medium degree (III) and 18.1% present superficial root system, that is, above the sidewalk, being able to become a root system that causes cracks in the sidewalks, first of medium degree, being able to later evolve to high grade cracks.

Breast Height Diameter (DAP)

For the preparation of Figure 3 of the chest height diameter (DAP), the measurements were divided into 4 parts, from 0.01 to 0.80 m, from 0.81 to 1.60 m, from 1.61 to 2.40 m and above 2.40 m.

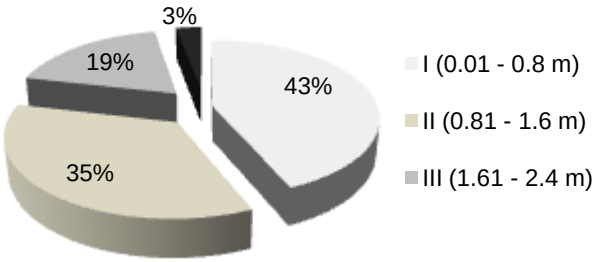

Figure 3 - Diameter of chest height expressed in (%) identified in Los Angeles garden. Source: The author

Among the species that have 0.01 to 0.8 m in diameter, *Licania tomentosa* stands out because 79.3% of all species found in the garden had this average diameter of breast height. The most frequent species with the height of the pectoralis II (0.81 to 1.6 m) are Caesalpinia peltophoroides with 48.5% of all the species implanted without the garden with this mean diameter and Licania tomentosa 20, 7% of all trees in this way the garden also has this diameter medium. The most frequent species with a diameter of 1.61 to 2.4 m (III) is *Caesalpinia peltophoroides* with 39% of all species implanted in the garden with this mean diameter. And the only arboreal species that has a breast height diameter greater than 2.41 m (IV) is the *Caesalpinia peltophoroides*, which represents 7.6% of all this species in the garden.

First bifurcation height (APB)

For the height of the first bifurcation, the measurements were divided into 4 parts, as well as the diameter of the chest height, being 0.01 to 0.80 m, from 0.81 to 1.60 m, from 1.61 to 2.40 m and above 2.40 m (Figure 4).

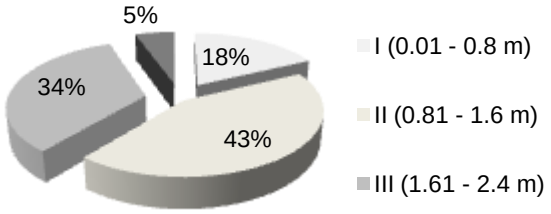

Figure 4 - Height of the first bifurcation expressed in (%) identified in Los Angeles garden. Source: The author

In this Garden, it has a larger number of Licania tomentosa trees with (116), stands out with about 22.4% of the total having the first bifurcation of 0.01 to 0.8 meter, besides having trees that have height of 0, 81 to 1.6 m, considered 54.3% of the total of this species in the neighborhood. The species *Caesalpinia peltophoroides* stands out among the species that are 1.61 to 2.4 m high in the first bifurcation, with 47.6% of the total in the garden (105). The tree species with more than 2.41 m of height of the first bifurcation with the highest percentage is *Tabebuia impetiginosa* with 27.3% of the total of the same in the garden.

Quantitative survey of Santo Antonio Garden

In the Santo Antonio garden were identified different tree species, totality the 14 species distributed along the same. According to the analyzes, the highest frequencies of trees were *Licania tomentosa* (72.4%), *Schinus molle* (8.3%), *Caesalpinia peltophoroides* (6.6%), *Pachira aquatica* (3.9%), *Tabebuia impetiginosa* (3%), *Tibouchina granulosa* (1%), *Syzygium cumini* (1%), *Ficus auriculata* (1%) and other species with less than 1% each.

About the origin of tree species in Santo Antonio garden about 97.6% are natives and 2.3% exotics. Of the species that are exotics about 2.3% represented by *Syzygium cumini* in greater quantity, in percentage data it represents 42.8% of all exotics trees, followed by *Cupressus lusitanica*, *Ficus elastica*, *Delonix regia* and *Bauhinia variegata*, all with 14,3%.

Family of tree species

The 14 species identified in the garden belong to 10 distinct families, the family Anacardiaceae (8.3%) with one species (*Schinus molle*), the family Bignoniaceae (3.3%) is represented by *Tabebuia impetiginosa*, family Bombacaceae (4,3%) is represented by *Pachira aquatic* and *Ceiba speciosa*, the family of Chrysobalanaceae (72.4%) is represented by *Licania tomentosa*, while the Cupressaceae family (0.5%) is represented by *Cupressus lusitanica*, and Fabacea (7%) is represented by *Caesalpinia peltophoroides*, *Bauhinia variegata*, *Delonix regia*, the family of Lauraceae (0.5%) is represented by *Ocotea pulchella*, the family Melastomataceae (1%) is represented in the neighborhood by *Tibouchina granulosa*, the family Moraceae (1.3%) is represented by *Ficus auriculata* and *Ficus elastica*, whereas the Myrtaceae family (1%) is represented by *Syzygium cumini*.

Planting site and root system

For the planting site of the tree species of the Santo Antonio garden, the results obtained are expressed in Figure 5 (%).

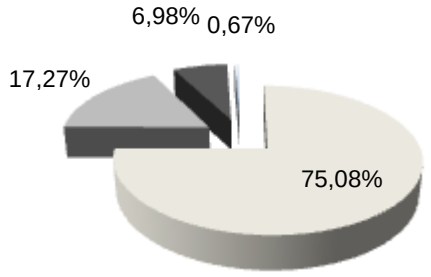

Figure 5 - Local planting of the species expressed in (%) identified in the Santo Antonio garden. Source: The author.

The species with the highest percentage of 0.5 to 1 m of the middle (I) were *Licania tomentosa* with 73.9% and *Schinus molle* with 7.9%, from those that were planted from 1.01 to 1.5 m of the middle (II) were *Licania tomentosa* 78.8% and *Caesalpinia peltophoroides* 7.7%, from those planted from 1.51 to 2 m (III), most were *Licania tomentosa* 40%, *Caesalpinia peltophoroides* and *Schinus molle*, both with 14.3% and trees planted more than 2.01 m from the middle (IV) 50% are *Caesalpinia peltophoroides* and 50% *Schinus molle*.

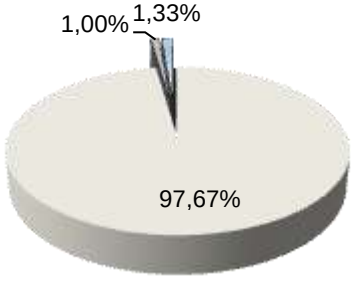

Figure 6 - Root system species expressed in (%) identified in the Santo Antonio garden. Source: The author

Due to the fact that it is a garden considered from mid to low age, when compared to the age of the municipality, the tree species present in it, are not so tall and nor is the root system so aggressive when compared to the previous neighborhood (Los Angles) that is high to medium age. As evidence of this are the percentage results obtained from the root system, where there are still no trees that present a superficial root system with cracks in the high grade (IV) sidewalk. Already those that present a superficial root system with cracks in the sidewalk, of low to medium degree (III) are represented as 50% being *Schinus molle* and 25% *Pachira aquatica* and *Caesalpinia peltophoroides*, and 1% of all the arboreal individuals of the garden present superficial root system (II), that is, above the sidewalk, being able to become a root system that causes cracks in the sidewalks, first of middle degree, being able to later evolve to high degree cracks.

Breast Height Diameter (DAP)

The Figure 7 presents results of the incidence (percentage) of individuals with a breast height diameter of 0.01 to 0.80 m, from 0.81 to 1.60 m, from 1.61 to 2.40 m and above 2,40 m.

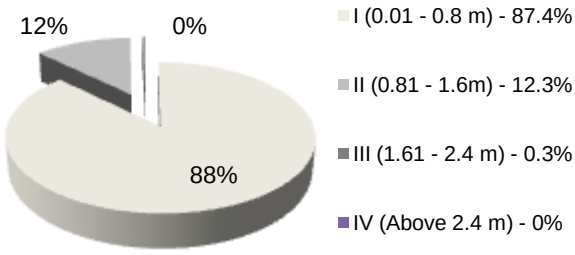

Figure 7 - Diameter of the chest height of the tree species expressed in percentages identified to the logo of the Santo Antonio garden. Source: The author

Among the species that have 0.01 to 0.8 m in diameter, the most striking is *Licania tomentosa*, because 96.8% of all species found in the garden had this average diameter of breast height. The most frequent species with the diameter of breast height (0.81 to 1.6 m) are the *Pachira aquatic* with 66.7% of all species implanted in the garden have this mean diameter and *Caesalpinia peltophoroides* 60% of all species trees of this species in the garden also have this average diameter. Already with the diameter of 1.61 to 2.4 m (III), only has a tree that is *Caesalpinia peltophoroides* with represents 5% of all species implanted in the garden with this average of diameter. And with the diameter of chest height greater than 2.41 m (IV) does not have any tree species.

First bifurcation height (APB)

Following the reasoning of the previous garden the figure for the height of the first bifurcation of the Santo Antonio garden was as follows.

The species *Licania tomentosa* presents a greater number of trees in this garden (218), standing out with 39.4% having the first bifurcation of 0,01 to 0,8 meters, besides presenting trees with 0,81 to 1,6 m (53.2%). The *Caesalpinia peltophoroides* species, with 40% of the total in the garden 20 species, stand out among the species that are 1.61 to 2.4 m high in the first bifurcation. The tree species with more than 2.41 m of height of the first bifurcation with the highest percentage is *Syzygium cuminicom* 66.6% of the total of the same in the garden.

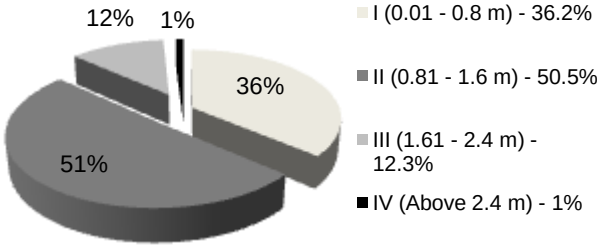

Figure 8 - Height of the first bifurcation expressed in (%) present in Santo Antonio garden. Source: The author

Conclusions

There was an expressive reduction of the presence of Sipipirunas (*Caesalpinia peltophoroides*) in the study areas, contemplating the idea of frequency of less than 15% of each species. Positive aspect observed was the use of Natives species corroborating with the environmental recommendations preserving the flora present in the biomes of the State and country. In the case of damages caused by root system, the low occurrence in the study areas was verified.

It is suggested to format the law indicating the height of the first bifurcation for the transportation of arboreal specimens in public roads, since there were significant differences between the Los Angeles garden when compared to the Santo Antonio garden.

Although many works are concerned with the importance of urban trees, one can not perceive a focused attention to this subject in the public policies of urban centers, because of their great relevance, few Brazilian cities have a planning effective for afforestation of its roads and public spaces.

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