

## Review Paper

# Qualitative and quantitative analysis of hedgerows in urban areas

### ABSTRACT

The research aimed to analyze the maintenance, composition, pruning, planting aspects and architectural elements on urban hedgerows. This study was carried out in an area of Imbiribeira, Recife, PE, Brazil, during six months. The survey was conducted in an area of 30 city blocks (37.024 hectares). The application of the questionnaire was directed to people residing, working, or owning real estate that contained hedgerows. Maintenance (person with the responsibility of pruning and maintenance of the hedge and types of maintenance performed on the hedges); Plant species aspects (species used were classified into groups of plant species: arboreal, shrub, herbaceous and climbing plants); Composition (~~Homogeneous~~ homogeneous or ~~Heterogeneous~~ heterogeneous); Pruning (~~Maintenance~~ maintenance or ~~Topiary~~ topiary); Planting aspects (planting alignment, spacing rhythm and dimensions of the hedge). In the study area, 30 blocks were sampled, where the presence of hedgerows was observed in 18 of them. The people responsible for the maintenance and management of hedgerows were mostly non-professional workers. The practice of watering hedgerows was found in 95.24 % of the visited properties. The use fertilizer was found in 28.57 % of the cases and only 4.76 % of the properties use pesticide products due to phytosanitary problems. Most of the hedgerows had a homogeneous composition. Topiary pruning is the most practiced treatment on the hedgerows, with a frequency of 82.28% in the study area. The quincux planting with no definite spacing rhythm was the most found. The most observed Planting Alignment in the study area was in line. The most observed Spacing Rhythm was the one with no rhythm of planting. Although hedgerows are widely used in urban and rural areas, studies on their maintenance, composition, structure, ecological importance and relevance to biodiversity conservation are scarce.

**Comment [U1]:** Add the percentage to the number, do this in all cases throughout the text

**Keywords:** Hedgerows, maintenance, pruning, green areas.

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### 1. INTRODUCTION

The conversion of green areas into built areas is one of the major reasons for the destruction of natural habitats in urban cities around the world. According to [1] no environment is more altered than the urban environment, due to the current models of buildings and land use that restrict the spaces that was once green areas. These restrictions limits the access to green areas in a urban environment.

According to [2], the urban green areas is characterized as one of the most important elements that compose the urban ecosystem. For the benefits that it produces, should be a permanent concern of any and all urban planning.

27 Plants influence climate as trees and other vegetables intercept, absorb and transmit solar  
28 radiation, improving air temperature in the urban environment. A single tree hardly affects its  
29 climate in a significant way, but being in groups or scattered, can be efficient in the  
30 microclimatic improvement and comfort sensation [3].  
31

32 There is a growing recognition of the benefits caused by the access to green areas on the  
33 improvement on public well-being [4]. Several researches have provided scientific evidence  
34 on the benefits of urban green areas on population health, in their different ages and  
35 different uses [5,6,7,8].  
36

37 Hedgerows such as lines of trees, shrubs or other plants are landscape elements used in  
38 many parts of the world. They are considered mainly by their cultural and ecological values.  
39 Hedgerows always have a human component that manages them to maintain control and  
40 prevent their expansion to adjacent areas. This human action is essential for the formation of  
41 hedges. Thus, the suggested definition would be a linear characteristic structure, composed  
42 of managed shrubs and / or trees [9].  
43

44 Hedgerows constitute an important part of our landscape, and can be an ideal frontier for  
45 gardens. They have many benefits, such as: reduce noise; provide shelter and natural  
46 habitats for animals such as insects, birds and mammals; pest control because they provide  
47 habitat for natural predators; provide privacy; security, thorny species provide obstacles for  
48 anyone trying to overcome them; they are visually attractive, may present different  
49 physiognomy according to the time. They can also act as green corridors for the movement  
50 of insect populations and increase the connection between the different parts of the hedges  
51 [9,10].  
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53 In addition to providing a valuable food source, hedgerows provide an attractive habitat for  
54 invertebrates, as they have a suitable microclimate, an environment for landing and mating,  
55 and protection against predators, climatic extremes, and harmful agricultural operations [11].  
56 Besides that, hedgerows provide a favorable environment for various birds such for nesting,  
57 shelters, feeding, shelter against predators and displacement.  
58

59 In some European countries, the implantation of hedgerows is widely used as a strategy for  
60 the conservation and preservation of wild animals, aiming to make anthropic environments  
61 more accessible to animals [9].  
62

63 Although the description and distribution of these elements have not yet been widely studied,  
64 hedgerows have a much wider distribution than can be perceived [12]. According to [13], in  
65 human cultural development is the use of plants that form hedgerows, which stand out as a  
66 characteristic feature of rural landscapes in many tropical American countries, in arid, semi-  
67 arid or humid regions.  
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69 According to [14], hedgerows are currently distributed in the humid, sub-humid, semi-arid  
70 and arid tropical regions of the world. It had been found in Latin America from prehispanic  
71 times, from Mexico to Peru. It is described as the most widely distributed agroforestry  
72 technology [15].  
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74 The study aimed to analyze the maintenance, composition, pruning, planting aspects and  
75 architectural elements on urban hedgerows.  
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## 77 2. MATERIAL AND METHODS

### 78 2.1 Study area 79

**Comment [U3]:** Add paragraphs and deepen the wording on the benefits of vegetation in urban areas, public health and the environment

**Comment [U4]:** Avoid paragraphs with a single sentence. Adjust throughout text in all cases

**Comment [U5]:** It is not clear if any method of identification of the species found was used, and if so, how was the procedure. Ethical issues need to be clarified. as questionnaires were applied, the authors need to report whether the study was approved by an Ethics Committee, which care was taken.

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Located in the eastern portion of the Northeast, at 8° 04' 03" south latitude and 34° 55' 00" west longitude, the RMR (Metropolitan Region of Recife) is located in the coast of Pernambuco. In The City of Recife in in central part of the RMR. The city has an average altitude of 4 meters. Recife has an eminently urban profile, with small rural population and small farming activities. Rich and diversified environments in continuous process of urbanization and economic exploitation.

The climate of the city of Recife, according to the classification of Köppen is rainy tropical, type Ams'. It is characterized by two distinct periods: the first is a dry season, which runs from September to February (spring-summer) and the second is the rainy season from March to August (autumn-winter). It is considered a fairly humid climate, with an annual precipitation above 750mm, average temperature ranging from 25° C to 30° C and relative humidity ranging from 79.2% to 90.7% in the wetter months.

## 2.2 Sample area

This study was carried out in an area of Imbiribeira, Recife, PE, Brazil, during six months. The neighborhood of Imbiribeira has 0.14km<sup>2</sup> of predominantly residential area, with commerce in its main streets. It presents a landscape characterized by the Atlantic Forest Biome, tropical climate, and average annual temperature of 21° C, with an average rainfall of 1400mm/year.

## 2.3 Survey

The survey was conducted in an area of 30 city blocks (37.024 hectares) consisting mostly of residential properties and a small park.

After the delimitation of the study area, the number of properties with hedgerows were registered. The application of the questionnaire was directed to people residing, working, or owning real estate that contained hedgerows.

The method for conducting the interview was based on qualitative and quantitative research with a semi-structured questionnaire, which, combined open and closed questions, where the person inquired has the possibility to discuss the proposed topic.

## 2.4 Maintenance

The person with the responsibility of pruning and maintenance of the hedge has been classified as: Owner, individual possessing the property containing hedgerows; Non-professional worker, person who does not reside in the property that has hedgerows, but has some working relationship with the owner of the property, not having technical knowledge; Professional of the area, person with technical knowledge, able to perform the correct maintenance of the hedge; and owner of the property, with some technical knowledge.

The interviewee was questioned about the types of maintenance performed on the hedges (pruning, watering, fertilizer, defensive products or others).

## 2.5 Composition

The hedgerows were classified according to their function and composition in: Homogeneous, when the hedge was composed of only one plant species, independent of

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132 the group of plant species; and Heterogeneous, when the hedge is composed of more than  
133 one plant species, independent of the group of plant species.

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## 135 **2.6 Plant species aspects**

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137 The species used were classified into groups of plant species: arboreal, shrub, herbaceous  
138 and climbing plants. From the survey of the species, the frequency of observation was  
139 observed.

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## 141 **2.7 Pruning**

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143 The treatment given to the individual members of the hedgerows was classified as:  
144 Maintenance, when only dry or diseased branches are eliminated through pruning,  
145 remaining the specific form of the species; and Topiary, when, in the presence of pruning,  
146 the shape of the canopy is changed for aesthetic purposes, creating hedgerows with carved  
147 aspect, modifying the natural form of the plants (generally in square or rectangular format).

148

## 149 **2.8 Planting aspects**

150

151 The planting alignment was characterized as: Line planting, when the planting was carried  
152 out in one or more lines with individuals opposing each other; and Quincunx planting, when  
153 the planting was carried out in two or more lines with individuals alternating each other.

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155 The spacing rhythm was classified as: spacing with rhythm, when the hedge had a standard  
156 spacing throughout its length and; Spacing without rhythm when the hedgerow had no  
157 standard spacing along its length. In the classification of the hedgerows with rhythm, the  
158 spacing used was noted. In hedgerows without rhythm, the range of spacing used was  
159 noted.

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## 161 **2.9 Dimensions**

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163 The Height (H), Width (w), Extension (E) and Planting Spacing of the hedgerows were  
164 measured with the aid of a measuring tape. With such data, the occupied area or Area of  
165 Projection (AP) of the hedgerow was calculated, and also the Area of Maintenance of the  
166 hedge (AM), that is, the total area of the hedgerow where pruning is practiced.

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168 The occupied area, or projection area (AP) of the hedge and the maintenance area (AM)  
169 were found according to the following equations:

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$$AP = W \times E \quad (1)$$

$$AM = 2 \times (H \times E) + 2 \times (H \times W) + (W \times E) \quad (2)$$

174

175 The calculation of the maintenance area was adjusted according to the need of each hedge,  
176 due to the fact that some hedgerows have one or more of their sides facing walls, and no  
177 maintenance is performed on these faces.

177

## 178 **2.10 Architectural elements on hedgerows**

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180 It was observed the absence or presence of architectural elements (walls, gratings, barbed  
181 wire, etc.) associated with the hedgerows as complementary materials to the structure of the  
182 hedgerows.

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184 From the obtained data, the total number of the analyzed blocks, the total number of  
185 hedgerows found in the study area, the average number of hedgerows found per block and  
186 the average number of hedgerows per analyzed properties were determined. The data was  
187 computed as Frequency (%), which was the percentage that each variable presented in  
188 relation to the analyzed variable.

### 190 3. RESULTS AND DISCUSSION

#### 192 3.1 Properties characterization

194 In the study area of the neighborhood of Imbiribeira, 30 blocks were sampled, where the  
195 presence of hedgerows was observed in 18 of them. In these, 73 hedgerows were surveyed  
196 with an average of 2.43 hedgerows per block. The presence of hedgerows was verified in 27  
197 properties, with an average of 2.70 hedgerows per property, of which 18 (66.67 %) are  
198 residential and 9 (33.33 %) belong to private companies.

200 Although, considering the low number of properties with hedgerows, the number of  
201 hedgerows surveyed in the area was above the expectations. Opening the possibility to  
202 consider that this system is valued in the area.

#### 204 3.2 Maintenance

206 The people responsible for the maintenance and management of hedgerows in the study  
207 area in the Imbiribeira neighborhood were mostly non-professional workers. Non-  
208 professionals represented 61.54 % of the cases, followed by professionals with 23.08 % and  
209 owners of the properties with 15.38 % (Fig. 1). These results show that the majority of  
210 hedgerow maintenance is conducted by people who only have empirical training. It is also  
211 noted that few owners personally manage their hedgerows.

213 The lack of knowledge of the professionals that deal with the hedgerows can contribute to  
214 several damages to the hedges. According to [16], bad pruning besides damaging the  
215 canopy, leaves the tree exposed to the attack of pests and diseases by the physiological  
216 stress imposed by this practice. The pruning period of the hedgerows should be evaluated  
217 according to the typology of the plant species. The duration and frequency of pruning is a  
218 variable that requires studies to quantify it, since it depends, among other factors, on the  
219 density of planting, type of pruning and quality of the work. The longer the interval between  
220 prunings, the thicker the pruned branches and the more disturbed the hedge will be.  
221 However, most plants are able to withstand this kind of damage. There are few plants that  
222 get sick or die for this reason. The gradual increase of pruning height and width will reduce  
223 the damages caused to the branches by pruning [17].  
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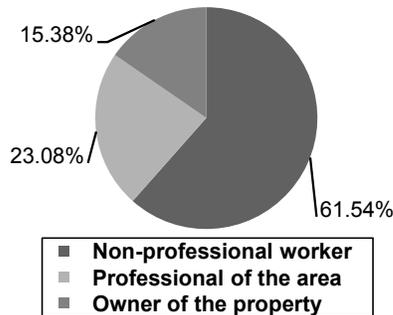
**Comment [U7]:** What software was used? refer

**Comment [U8]:** All tables and figures require formatting.

**Comment [U9]:** A table with the frequencies of the species found in the study would allow a better understanding

**Comment [U10]:** How many people answered the questionnaire?

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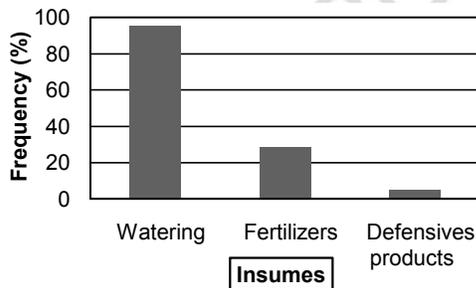
**Fig. 1. Responsible for the maintenance and conduction of the hedgerows in the study area in the neighborhood of Imbiribeira, Recife, PE, Brazil**

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The practice of watering hedgerows was found in 95.24 % of the visited properties. The use of fertilizer was found in 28.57 % of the cases and only 4.76 % of the properties use pesticide products due to phytosanitary problems (Fig. 2).

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In a study about hedgerows, [18] found that over 40% of farmers have already used herbicides in weed control. More than half were always careful that herbicides did not come into contact with live fences, while 9% never used herbicides. This work also showed that selective herbicides can be valuable in the recovery of highly weed infested hedges. Treatments with herbicides also increase the diversity of bed bug species (Heteroptera) [19]. This can be beneficial from an ecological and agronomic point of view, although it is pointed out that other weeds can be beneficial to insects.



**Fig. 2. Watering and Insumes used to maintain hedgerows in the study area in the neighborhood of Imbiribeira, Recife, PE, Brazil**

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### 3.3 Composition

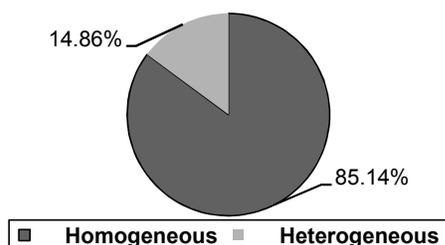
Most of the hedgerows had a homogeneous composition, representing a frequency of 85.14% of the study area of the Imbiribeira neighborhood (Fig. 3). Hedgerows with heterogeneous composition presented a frequency of 14.86%.

255 In a study carried out in rural area of Abreu e Lima/ PE, a predominance of hedgerows with  
256 heterogeneous composition was observed [20]. The introduction of more species to increase  
257 diversity in the construction of hedgerows can be a tactic to reduce pest impacts.  
258

259 Hedgerows composed by a larger diversity of species can provide more benefits to the  
260 wildlife than the ones composed by only one species [19,21,22]. Although heterogeneous  
261 hedgerows have a greater ecological importance in terms of plant species diversity and  
262 importance to fauna, the preference for hedgerows with homogeneous composition is higher  
263 in urban areas. The homogeneous composition of hedgerows, when subjected to proper  
264 maintenance, give the environment a pleasant and elegant visual appearance. This is why  
265 their adoption is predominant in urban areas.  
266

267 In a study about the importance of hedgerows, composed by different plant species, in the  
268 density and diversity of spiders, [23], observed that spiders can present preferences for  
269 determinate plant species in different seasons, as well as preference for hedgerows instead  
270 of another agroforestry systems.  
271

272 The plants diversity is one of the most important components of the urban ecosystem  
273 because it provides several ecological benefits and contributes directly to the quality of life  
274 and well-being of the population [24,25]. The diversity of species can contribute to conserve  
275 local biodiversity by preserving native tree species in urban environments and providing  
276 natural habitats for local animal species [26].  
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279  
280 **Fig. 3. Composition of hedgerows (homogeneous or heterogeneous) in the**  
281 **neighborhood of Imbiribeira, Recife, PE, Brazil**  
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### 284 **3.4 Pruning**

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286 Topiary pruning is the most practiced treatment on the hedgerows, with a frequency of  
287 82.28% in the study area (Fig. 4). Hedgerows that exhibit uniformity have a more pleasant  
288 visual appearance, which is why most of the hedgerows are subjected to frequent topiary  
289 pruning aiming for uniform growth of the individuals that compose the hedgerow.  
290

291 A research about hedgerows in the city of Abreu e Lima, in Pernambuco, reported that only  
292 one of the hedgerows evaluated was managed with maintenance pruning [20]. A lower  
293 frequency of hedgerows treated with maintenance pruning was found in the study area.  
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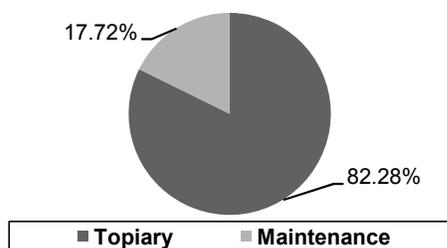
295 In the maintenance pruning of hedges, it is important to ensure that the lower part of the  
296 plant does not remain in the absence of light. This error is very common and its main  
297 consequence is the emergence of leafless bases, with flaws and dead or diseased  
298 branches. This problem happens mainly when the hedgerow has a square shape, because

299 the superior part will always grow more than the lower one, because it will receive more light  
300 [26]. Although this practice was not studied in this research, there was no hedgerows  
301 presenting the pruning suggested by the author.

302  
303 The management of hedgerows controls its various structural parameters such as width,  
304 height, density and vegetation stratification, determining its value for invertebrates [11].

305  
306 According to [19] the effects of time and frequency of pruning are determinant for the  
307 presence of populations of some arthropods species. Some populations of insects show  
308 higher growth in hedgerows that are not pruned, while others are more abundant in pruned  
309 hedgerows. This fact can also happen when the period of the year in which pruning is  
310 performed is considered. Due to this fact, the authors recommend that not all individuals  
311 composing a hedgerow should be pruned at the same time.

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316 **Fig. 4. Treatments given to hedgerows in the study area in the Imbiribeira**  
317 **neighborhood, Recife, PE, Brazil**

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319 Hedgerows composed of climbing species receive mostly topiary pruning, with a frequency  
320 of 92.31% (Fig. 5). While in hedgerows composed of herbaceous species, only maintenance  
321 pruning was noted. This is due to the different aesthetics of the species, making pruning not  
322 necessary to modify the structure of the species.

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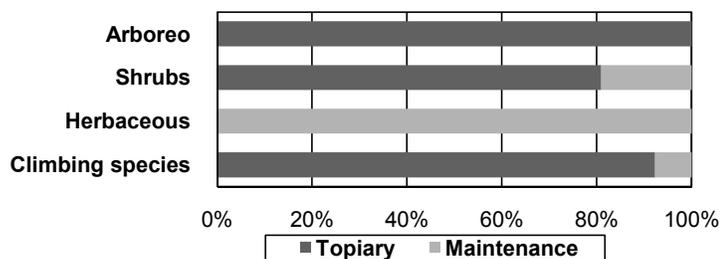
324 Hedgerows with shrub species were subjected to both topiary and maintenance pruning in  
325 the study area with frequencies of 80.95% and 19.05%, respectively.

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327 Hedgerows composed of tree species were submitted, in most cases, to topiary pruning in  
328 100.00% of the cases in the Imbiribeira neighborhood.

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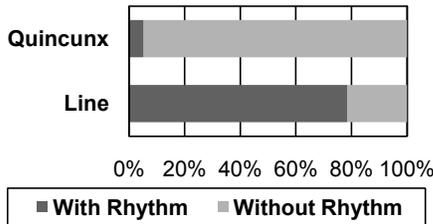
333 **Fig. 5. Treatments given to hedgerows in the different groups of plant species in the**  
 334 **study area in the Imbiribeira neighborhood, Recife, PE, Brazil**

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335  
 336 **3.5 Planting aspects**  
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338 The quincunx planting with no definite spacing rhythm was the most found in the study area  
 339 with a frequency of 94.74% (Fig. 6). The rhythm of spacing most used in line plantings was  
 340 with rhythm, with a 78.57% frequency.  
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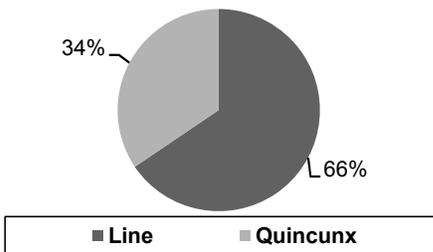
342 Double row planting with intercalated pits (quincunx) can form wider hedgerows in a shorter  
 343 time. Depending on the owner's purpose or preference, the width of the hedgerows may be  
 344 influenced by the alignment chosen at the moment of implantation of the hedge. Larger  
 345 hedgerows can be obtained through quincunx plantations and hedgerows of smaller widths  
 346 can be obtained with plantings in rows. However, this type of planting eventually consumes  
 347 more space in the garden. The single line can be formed by aligned grooves or holes and  
 348 occupy less space.  
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 353 **Fig. 6. Relation between Spacing Rhythm and the Planting Alignment used in the**  
 354 **hedgerows of the study area in the Imbiribeira neighborhood, Recife, PE, Brazil**

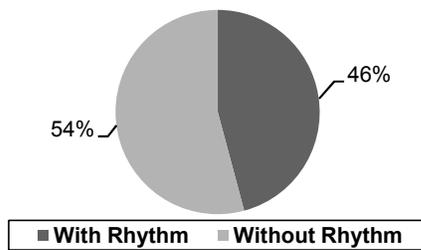
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356 The most observed Planting Alignment in the study area was in line, with a 65.58%  
 357 frequency (Fig. 7). The quincunx alignment was observed in 34.48% of the cases. Even  
 358 though the quincunx alignment is able to form wider hedgerows, the line alignment is the  
 359 most common used.  
 360  
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362  
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 364 **Fig. 7. Planting Alignment used in the hedgerows of the study area in the Imbiribeira**  
 365 **neighborhood, Recife, PE, Brazil**  
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367 The most observed Spacing Rhythm was the one with no rhythm of planting, with a  
368 frequency of 54.17% (Fig. 8). This fact could be explained due to the death of individuals or  
369 new individuals added to the hedgerow. The spacing with rhythm was observed in 45.83% of  
370 the cases.  
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375 **Fig. 8. Spacing Rhythm used in the hedgerows of the study area in the Imbiribeira**  
376 **neighborhood, Recife, PE, Brazil**  
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378 There is a difficulty in measuring the spacing and pace of spacing due to death of individuals  
379 or individuals entering the hedge. Due to the fact that the present research carried out the  
380 survey of the hedgerows in just one moment, the data exposed disregarded dead  
381 individuals, taking into account only the current arrangement.  
382

383 The most used range of spacing in hedgerows composed of herbaceous plants in the study  
384 area was 0.00m to 0.20m and 0.21m to 0.40m, with a 50% frequency each (Fig. 9).  
385

386 Hedgerows composed of shrub species had more frequent spacing in the range of 0.21m to  
387 0.40m, presenting a frequency of 58.33%, followed by the range 0.00m to 0.20m, with a  
388 29.17% frequency. This group was also found with other spacing range, but with a lower  
389 frequency.  
390

391 Hedgerows composed of tree species presented the planting spacing only in the range from  
392 0.81m to 1.00m.  
393

394 In general, the most widely used spacing range in planting hedgerows was 0.21m to 0.4m  
395 with a frequency of 56.86% for the study area.  
396

397 A common practice is to reduce the spacing between the seedlings in order to accelerate the  
398 formation of the hedgerow. Thus, the roots and branches will overlap, generating  
399 competition for light, water and nutrients and impairing the development and health of the  
400 plants. Instead, it is preferable to acquire more developed seedlings, respecting the  
401 recommended spacing for each species [27].  
402

403 The appropriate spacing between the seedlings varies from species to species and should  
404 always be respected, otherwise the roots and branches will overlap, generating competition  
405 for sunlight, water and nutrients and impairing the development and health of the plants.  
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407 The range of spacing of the climbing plants were not possible to measure.  
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**Fig. 9. Range of Spacing used in different groups of species that compose hedgerows in the study area in the Imbiribeira neighborhood, Recife, PE, Brazil**

**3.6 Dimensions**

It was possible to observe a greater height for the climbing species, according to Table 1, due to the fact that the plant has to be adequate in proportion to the height of the support, which are generally high walls. The dimensions of climbing species, in general, fit the dimensions (height, width and extension) of the support.

The average heights of hedgerows formed by herbaceous and shrubs were similar, with 0.95m and 0.98m respectively.

The width of hedgerows showed a tendency to increase according to the natural size of the group of species. The average widths found in hedgerows composed of herbaceous and shrubs species in the study area presented averages of 0.48m for herbaceous and 0.67m for shrubs. The average values of width found for hedgerows composed of trees were 1.50m.

The maintenance areas found presented an average of 45.37m<sup>2</sup> in climbing plants, 10.63m<sup>2</sup> in herbaceous plants, 12.13m<sup>2</sup> in shrubs, and 18.55m<sup>2</sup> in trees of the study area. These dimensions in conjunction with the extension and the projected area can be used to make a better plan of the hedgerows maintenance and pruning considering time and costs.

**Table 1. Dimensions of hedgerows in the different groups of species in the study area in the Imbiribeira neighborhood, Recife, PE, Brazil**

Average values	Group of Species			
	Climbing species	Herbaceous	Shrubs	Arboreal
Height (m)	2.60	0.95	0.98	1.85
Width (m)	0.15	0.48	0.67	1.50
Extension (m)	10.32	4.08	4.36	2.50
Area of Projection (m <sup>2</sup> )	2.34	1.92	2.67	3.75
Area of Maintenance (m <sup>2</sup> )	45.37	10.63	12.13	18.55

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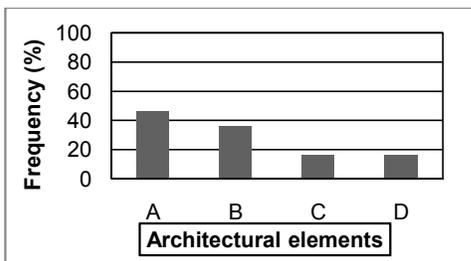
**3.7 Architectural elements on hedgerows**

Most of the hedgerows did not present complements in their structure or in their proximity (Fig. 10).

444 The presence of walls was verified in 35.62% of the hedgerows in the study area,  
445 representing the highest frequency among the verified elements.

446  
447 The presence of hedgerows complementing fences of grids presented 16.44% of frequency  
448 in the studied hedgerows, and has as function the privacy to one or both sides of the  
449 hedge. The presence of low walls was found with the same frequency.

450  
451 The use of barbed wire was not observed in hedgerows in the study area.  
452  
453



454  
455  
456 **Fig. 10. Architectural elements associated with hedgerows in the study area in the**  
457 **Imbiribeira neighborhood, Recife, PE, Brazil. Where: A – No complements; B –**  
458 **Presence of high walls (above 0.5 m); C – Presence of low walls (under 0.5 m); D –**  
459 **Presence of grids**

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#### 460 461 4. CONCLUSION

462  
463 Throughout the study area a considerable amount of relatively well conserved hedgerows of  
464 varying sizes could be witnessed.

465  
466 Although heterogeneous hedgerows have a greater ecological importance in terms of plant  
467 species diversity, there was a preference for hedgerows of homogeneous composition for  
468 providing pleasant and elegant aesthetics.

469  
470 Hedgerows that have uniformity have a more pleasant visual appearance, which is why most  
471 of the hedgerows are subjected to frequent topiary pruning. This promotes uniform growth of  
472 the individuals that compose the hedgerow.

473  
474 Although hedgerows are widely used in urban and rural areas, studies on their composition,  
475 structure, ecological importance and relevance to biodiversity conservation are scarce.

#### 476 477 COMPETING INTERESTS

478  
479 Authors have declared that no competing interests exist.  
480

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