

CHARACTERISTICS AND HEALTH CONDITIONS OF THE LINDEN TREES (*TILIA SP.*) IN THE AVENUE LAYOUT OF NAŁĘCZOWSKA STREET IN LUBLIN

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ABSTRACT

Old avenues, or alleys of trees, form an important part of the cultural landscape. They used to be planted mainly in gardens and parks; later, they started playing an even more important role, particularly in the open areas, and within urban landscapes. Nowadays, they are frequently regarded as inconvenient formations, which exert a negative impact on traffic and impede road construction. However, it is worth bearing in mind that avenues play a number of crucial functions in terms of climate, ecology and aesthetics, and as such they deserve particular care. The article is devoted to the linden trees planted in an avenue layout along the Nałęczowska street in Lublin town in Poland. The layout currently consists of 85 individual trees in varying health condition, that is, 35% of healthy trees, nearly half exhibiting signs of reduced vitality, and 16% in the state of advanced decay.

Key words: small-leaved lime, linden, *Tilia cordata* Mill., Lublin, avenue layout

INTRODUCTION

Planting trees in the avenue system was known and used as early as in antiquity. At that time, trees growing by the roads were supposed to provide shade and sometimes also fruit [Dudkiewicz 2014]. In the following epochs, the tradition of avenue compositions made of woody plants continued. In Europe, avenue trees have been introduced into the cities along the newly outlined boulevards and promenades, during the Baroque and the Enlightenment periods. They formed the compositional matrix of cities [Fortuna-Antoszkiewicz 2002, Błaszczuk and Kosmala 2009]. Tree alleys were founded in gardens and parks, and starting from the seventeenth century, also in the open landscape. Initially, the avenues were tree-lined approach roads leading to aristocratic residences, and from the eighteenth century onwards, they became a popular

element of the countryside, and of the urban areas, where they decorated streets and squares [Krosigk et al. 2003, Worobiec and Liżewska 2009, Siewniak and Bobak 2010, Podolska 2013, Ziemiańska and Dworniczak 2014, Renda 2015]. In Poland, the first large avenues were founded for King Jan III Sobieski, but the universal planting of trees along the streets and in city squares was only begun in the nineteenth and twentieth centuries [Zielonko 1977b, Siewniak and Siewniak 2001, Fortuna-Antoszkiewicz 2002, Błaszczuk and Kosmala 2009, Mazur and Bach 2017]. During this period, great attention was paid to the aesthetics of space, but also the importance of vegetation in cities for health and hygiene was emphasized [Fortuna-Antoszkiewicz 2002].

The avenue layout is a communication route that is lined with trees, planted bilaterally. It has a specific composition, which consists of: the type of rhythm,

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distance from the road, tree canopy, distance between the individual trees, arborescence (tree form), and plastic variability in time [Dworniczak i Ziemiańska 2014, Ziemiańska and Dworniczak 2014]. Distinctive features also include a simple course, and a specific goal of the avenue [Krosigk et al. 2003]. In Poland, the most popular are single-row alleys (with one row of trees along each side of the road). It happens that the avenues stretch over very long sections of the road, they may even connect neighbouring towns with each other. Much less frequent are two-row and multi-row alleys, or trees that stretch on one side of the road, i.e. tree lines also called hedges [Wejchert 1984, Podolska 2013, Raszeja 2013, Ziemiańska and Dworniczak 2014].

Avenues are usually made up of one species of trees. In the past, elms, lindens, chestnuts, beeches, and poplars were used most frequently for this purpose. The hedges were formed mainly from hornbeam, as well as linden, elm, beech, and maple [Majdecki 1981]. Currently, the most popular species include the English oak, small-leaved lime, maple, or ash. Avenues composed of fruit trees are much less common: apple, pear, cherry, or walnut. Historically, species with longer life spans were often used in avenue plantings, and this is the reason why we can still find such historical landscape design elements, constituting a valuable, historical heritage [Krosigk et al. 2003, Podolska 2013, Raszeja 2013, Ziemiańska and Dworniczak 2014, Durlak et al. 2015].

The most important functions of avenue systems include determining the course of the route, as well as protection from wind and sun. The avenues also reduce road noise, and they limit the spread of air pollutants to the surrounding areas. Old alley trees are often habitats for small animals, fungi and lichens, therefore they contribute to increasing biodiversity. They also perform a decorative and ornamental function, and in cities, they often provide landmarks, decisive for the local image and identity [Krosigk et al. 2003, Siewniak and Bobak 2010, Jańczak-Pieniążek and Piłkuła 2013, Ziemiańska and Dworniczak 2014, Dynowski et al. 2016].

The aim of the present study was to take inventory and examine the health status of linden trees, growing in the avenue layout along Nałęczowska street in Lublin.

MATERIAL AND METHODS

For the purpose of this study, topical literature has been analysed, and field studies were carried out, including taking the inventory of trees growing in the avenue system, and examining their health condition. For selected specimens, their trunk circumferences were measured at the height of 130 cm. The research was conducted in July and August of 2017 in Lublin, Poland.

In determining the health condition of trees, the modified scale of Pacyniak and Smolski was applied [Pawlaczyk and Jermaczek 2009]. The condition of the trees has been described by a point scale, where: 1 – defines a completely healthy tree; 2 – denotes a tree with partially dying thinner branches in the apical part of the crown (up to 30%) and with single pests; 3 – identifies a tree in which 31-50% of the crown or trunk has died off; 4 – denotes a tree in which 51-70% of the crown or trunk has died; 5 – is a dead tree, or one that has died in more than 70%.

Distances between trees are given in metres.

The age of the trees was estimated based on Majdecki's age table of trees [1986].

The naming of trees was adopted after Seneta and Dolatowski [2012].

RESEARCH RESULTS

The object included in the research is the feature of linden trees planted in a single-row avenue system, located at Nałęczowska street in Lublin (see: Figure 2). The latter is a road with an asphalt surface, stretching from Aleja Kraśnicka towards the western border of the city, and running along the provincial road No. 830 towards Nałęczów.

The exact date of planting the linden trees along Nałęczowska street is not known. According to Mącik [2017], most of the older avenue layouts within the administrative borders of modern Lublin had been established since the beginning of the nineteenth century; and the current recognition of the importance of historical roadside avenues in the city remains unsatisfactory. The avenue layout described herein is not a listed historical, natural monument.

At present, the studied complex consists of 85 linden trees. Included in their number are all the specimens growing in rows on both sides of the street. Also

included were three additional lindens, which form a semicircle surrounding a roadside crucifix adjoining to the avenue layout, and which had been planted on the line of one of the rows; these three lindens correspond in age to the remaining trees. Linden trees located outside of the tree rows, and clearly separated from them, for instance by means of a pavement, were not included.

Linden tree plantations start at the intersection of Nałęczowska and Biskupińska streets, and they continue until the intersection with Dąbrowicka street. According to the measurement performed online by means of the Google maps, this section has a length of 2100 metres. The width of the avenue system is 8 metres.

In places where continuity of the planted trees is maintained, they grow at regular intervals of 10 metres. After performing the calculations for two tree sequences within the tested section, and assuming that the length of the avenue has not been shortened, it can be concluded that it should consist of 420 specimens of linden trees (210 trees on each side of the street). The calculations indicate that the current form is only 20% that remains from the former plantation.

The vast majority of trees forming the described layout are small-leaved lime, i.e. *Tilia cordata* Mill. However, there are also specimens of large-leaved linden, i.e. *Tilia platyphyllos* Scop. (6 specimens), and silvery linden, i.e. *Tilia tomentosa* Moench. (7 specimens). Hybrids are occurring only sporadically (3 specimens).

The circumference of the trunk at 130 cm is on average between 150 and 300 cm. Young specimens were rarely found, with circumferences of several dozen centimetres, which were planted later to fill empty spaces. Partially, there are also individual specimens growing back after cutting, as evidenced by the accumulation of several trunks in one place. Among the trees, the thickest specimens attract attention. The largest trunk circumference found among small-leaved limes was 354 cm, while the thickest tree in the alley was a silver linden with a circumference of 430 cm. According to data from Majdecki's age table of trees [1986], the age of linden trees, both of small-leaved and large-leaved lime species, is estimated depending on the thickness of the trunk at between 60 and 120 years. Silver linden has not been included in the abovementioned table, although its presence in the plantation indicates that it originated in the same period. Single small-leaved

limes and the thickest silver lindens in the entire alley exceed 314 cm in circumference, which is the minimum size that qualifies a given tree for the status of a protected natural monument. However, according to Pawlaczyk and Jermaczek [2009], in the case of a tree avenue, a natural monument can also be listed with considerably smaller tree circumferences. Occurrence of trees that are impressive in terms of size in the plantation testifies to the latter's high cultural, historical and natural value. According to Łukasiewicz [1989], over a period of ten years, one tree produces as much oxygen as man consumes in twenty years of life. Old specimens with high leaf mass are much more efficient in this respect. For example, during the growing season, a 100-year-old beech produces 1200 litres of oxygen in only one hour. The same amount can be produced by about 2700 young trees of small size [Kosmala 2005]. Trees also absorb carbon dioxide and numerous pollutants. According to Wójcicka [1971], in the streets equipped with a green belt of a 500 metres width, the amount of dust pollution is three times lower than in the streets without greenery. It is therefore worth our while to cherish all trees, treat them with care, and strive to maximize their life span.

The health condition of the trees forming the avenue system varies. Only 35% of the lindens are completely healthy trees (see: Figure 1). Trees in this

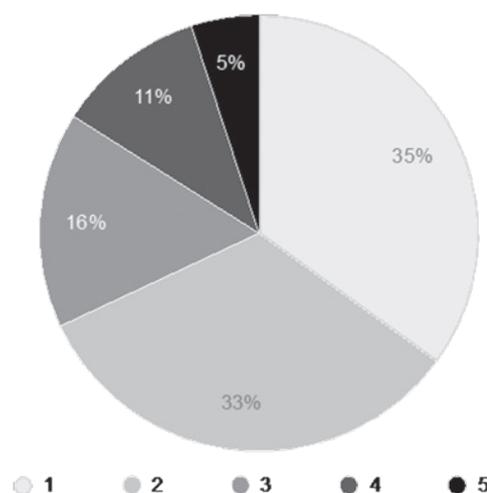


Fig. 1. Health condition of trees in the linden avenue in Lublin at Nałęczowska street: 1 – healthy trees, 2 – trees in a good condition, dry branches up to 30%, 3 – crown or trunk of the tree with 31–50% dieback, 4 – crown or trunk of the tree with 51–70% dieback, 5 – dying and dead trees

group exhibited shapely crowns as well as abundant, regular foliage. No irregularities were observed within their trunks or branches.

A similar amount (33%) were trees in which signs of decline in vitality were beginning to appear. There were slight deficiencies in the foliage at the ends of their branches, and some silhouettes began to tend towards that of a “tree with horns”, associated with the above [Szczepanowska 2010]. There were single missing branches that were the result of earlier sanitation cuts, as well as some dead branches that need to be removed. Single hollows and cavities in trunks were observed.

Another 16% of the trees were characterized by severe symptoms of weakness. The reduction in leaf density was very pronounced here, and crowns with

“horns” were strongly marked. There were numerous traces of cut branches, whose deficiencies caused asymmetry of the crowns. Hollows and cavities in trunks appeared in abundance. The branches of two of the observed trees broke off during the research period.

The remaining 16% are the trees, the condition of which can be described as poor. Some of them (11%) are specimens, in which the crowns either were dead in more than 50%, or there was a large portion of deadwood in combination with other signs of dieback. There were dead branches, numerous hollows, and hollow trunks in large sections. Isolated specimens (5%) were observed to be dying off completely, and will require removal in the near future.

The results of linden trees health assessment are presented in Tables 1 and 2.

Table 1. Inventory of linden tree avenue in Nałęczowska street – left side, direction from Lublin to Dąbrowica

No.	Species	Health assessment of trees according to the Pacyniak-Smolski scale	The number of trees	Comments
1.	Small-leaved lime <i>Tilia cordata</i>	1	14	Good condition, symmetrical crowns, rich foliage, well preserved trunks
		2	10	Dry branches in the crown of the tree: 20%, truncated single branches, single hollows
		3	7	Dry branches in the crown of the tree: more than 30%, a branch broken during the summer storm in one of the trees, truncated branches, hollows
		4	1	Dry branches in the crown of the tree: 45%, 1 branch of the tree is dying down, there are hollows
		5	2	Dying trees, numerous dry branches, a big hole in the trunk
2.	Large-leaved lime <i>Tilia platyphyllos</i>	1	1	A dozen thin trunks that grow after felling of an old tree
		1	4	No comments
3.	Silver lime <i>Tilia tomentosa</i>	2	1	The main branch of the tree cut off, hole in the trunk
		3	1	The tree with 2 trunks, one of them has numerous dry branches, the largest <i>circumference</i> : 430 cm (see: Figure 3)

Table 2. Inventory of linden tree avenue in Nałęczowska street – right side, direction from Lublin to Dąbrowica

No.	Species	Health assessment of trees according to the Pacyniak-Smolski scale	The number of trees	Comments
1.	Small-leaved lime <i>Tilia cordata</i>	1	8	Good condition, symmetrical crowns, rich foliage, well preserved trunks. The biggest small-leaved lime (circumference: 354 cm) is included in this group.
		2	13	Dry branches in the crown – up to 30%, single boughs dead or removed, visible hollows
		3	4	Numerous trimmed boughs, visible reduction of the crowns (“horned tree” silhouettes), hollows and holes in trunks, one tree with a recently broken branch
		4	8	Dry branches in the crown of the tree: more than 50%; trimmed branches, holes in trunks, hollows
		5	2	Dry branches in the crown of the tree: more than 70%, dying trees
2.	Large-leaved lime <i>Tilia platyphyllos</i>	1	2	No comments
		2	1	Single dry branches
		3	1	Numerous dry branches, visible reduction of the crowns with marked “horns”
3.	Silver lime <i>Tilia tomentosa</i>	2	1	Dry branches in the crown of the tree
		3	1	Dry branches in the crown of the tree: more than 30%, visible reduction of the crowns, “tree with horns” silhouette, circumference: 390 cm
4.	Common lime <i>Tilia xeuropaea</i>	1	1	Dry branches in the crown of the tree: 25%
5.	Caucasian lime <i>Tilia</i> ‘Euchlora’	2	1	Dry branches in the crown of the tree: 10%
6.	Lime <i>Tilia</i> sp.	2	1	Good condition, large hole up to 1/3 the height of the trunk

The avenue is situated on the road leading from Lublin to Nałęczów, which is burdened with an increased traffic due to commuters travelling from nearby towns for work in Lublin, while in the winter, it is systematically sprinkled with salts in order to eliminate the slipperiness of the surface. According to some authors [Bugala 2000, Bach et al. 2007, Borowski 2009, Sen-

eta and Dolatowski 2012, Sadowiec and Gawroński 2013], such salts flowing down from the roadway, soaking into the adjoining ground, and settling on the trunks in the form of salt spray, negatively affect the sensitive species of plants, which include small-leaved linden trees, the species that is the most numerous in this particular avenue.



Fig. 2. Linden alley in Lublin at Nałęczowska street, October 2017 (photo by J. Renda)



Fig. 3. Silver linden tree, *Tilia tomentosa* in Lublin at Nałęczowska street, October 2017 (photo by J. Renda)

CONCLUSIONS

Avenue system located at Nałęczowska street is an important element of the cultural landscape of Lublin. According to the studies conducted in 2017, it is made up of 85 trees, the vast majority of which have been recognized as small-leaved lime *Tilia cordata* Mill. The studies we have conducted allowed us to determine that the current form is probably a 20% that remains from the former plantation. The health condition of trees is not ideal. Half of them show clear signs of weakness, in varying degrees. Among the trees presenting poor health condition (16%), there are individual specimens that are dying off. Only 35% of the linden trees were determined to be completely healthy. Trees in poor health, with a deformed crown and damaged root system, not only will fail to perform their functions properly, but they may pose a threat

to people and property, as a result of fall or breakage. This indicates the need to conduct regular inspections of their condition, in order to eliminate potential future threats.

Among the trees, there are specimens of impressive size, whose circumference at the height of 130 cm exceeds 300 cm. The thickest tree was the silver lime of *Tilia tomentosa*, which testifies to high resistance and good growth of that particular species in the urban street-side conditions [Bugala 2000, Seneta i Dolatowski 2012, Sadowiec and Gawroński 2013]. Therefore, the species should be often included in the planned plantings of trees in urban areas, and in certain specific situations, it could even replace a small-leaved lime, which is sensitive to salinity. Unfavourable conditions for the growth of street-side trees, as well as the lack of proper care thereof, reduce their resistance to diseases and infections, and

increase their susceptibility to infestation by pests [Kropczyńska-Linkiewicz 2003, Tylkowski 2006, Kollar et al. 2009, Suchocka 2011]. Aesthetic value of linden trees in the summer – especially the small-leaved lime – can also be reduced by the saprophytes, i.e. saprophytic fungi growing on leaves covered with honeydew secreted by the caps and aphids. The resulting black coating not only reduces the decorative value of the plants, but it also reduces the photosynthetic area and makes photosynthesis of leaves more difficult [Wałęza 2006]. As a consequence, the weakening of trees by diseases and pests, as well as the improper care, may contribute to early leaf shedding and even dieback. According to Łukaszewicz [2008], in the small-leaved lime growing in unfavourable urban conditions, the growing season can be reduced by up to 30 days compared to trees growing in parks. According to many authors [Boratyńska and Dolatowski 1991, Fober 1991, Giertych 1991, Bach and Frazik-Adamczyk 2006, Greinert 2011], small-leaved lime – the most abundant species in the discussed group of trees – is very sensitive to soil salinity and moderately sensitive to SO₂, in comparison with other tree species. Furthermore, in the trees growing near the roadway, due to the settling on the sprouts and buds of a high concentration salt aerosol, arising as a result of the passing vehicles spraying saline water, anomalies of growth and crown deformation may occur [Zimmerman and Jull 2006, Bach et al. 2009, Borowski and Pstrągowska 2010, Borowski 2012, Mackoś-Iwaszko 2014]. It should therefore be assumed that the impaired health of linden trees growing in the avenue system is going to deteriorate further in the coming years.

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CHARAKTERYSTYKA I STAN ZDROWOTNY LIP (*TILIA* SP.) W UKŁADZIE ALEJOWYM PRZY UL. NAŁĘCZOWSKIEJ W LUBLINIE

ABSTRAKT

Stare aleje są ważnym kulturowym elementem krajobrazu. Dawniej zakładane były głównie w ogrodach i parkach, nieco później zyskały na znaczeniu w krajobrazie otwartym i w miastach. Obecnie często uznawane są za element kłopotliwy, spowalniający ruch i utrudniający dostosowanie dróg do współczesnych standardów. Warto jednak pamiętać o pełnionych przez aleje licznych funkcjach: klimatycznych, ekologicznych, estetycznych i otaczać je należy opieką. Artykuł dotyczy lip w układzie alejowym przy ul. Nałęczowskiej w Lublinie. Obecnie układ tworzy 85 drzew. Ich stan zdrowotny jest zróżnicowany: 35% stanowią osobniki zdrowe, prawie połowa wykazuje oznaki obniżonej vitalności, 16% to drzewa w znacznym stopniu zamierające.

Słowa kluczowe: lipa drobnolistna, *Tilia cordata* Mill., Lublin, układ alejowy