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Evaluation of tree measurements after the reconstruction of tree-row system in five narrow streets of Debrecen

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SUMMARY

Viable urban environment is largely dependent on the size, condition and distribution of urban green spaces within and around cities. Tree-rows in streets are one of the most essential elements of urban green spaces. The aim of this study was to evaluate tree taxa compositions and lifespan values of trees in tree-row system with special reference to five narrow streets (Garai, Jókai, Tanító, Csokonai and Zsák) of Debrecen. Tree numbers, tree taxa and the origin of tree taxa were determined in two years (2009 and 2017). As a next step, six selected taxa (Pyrus calleryana 'Chanticleer', Acer tataricum, Sorbus intermedia 'Browseri', Magnolia kobus, Acer platanoides 'Olmsted', and Crataegus x lavalleei 'Carrierei') were further estimated for the following lifespan parameters: i) trunk diameter (cm), ii) tree crown size (m), iii) trunk status (in 0–5 grades), iv) tree crown status (in 0–5 grades), v) estimated tree viability (in 0–5 grades), and vi) tree value in Ft. Our results showed that the numbers of tree taxa were 9 and 11 in 2009 and 2017 as well as an overall 279 and 282 trees were evaluated in 2009 and in 2017, respectively. More than 60% of the trees were native or similar to native taxa. The largest and the lowest trunk diameters were achieved for Pyrus calleryana 'Chanticleer' and for Acer tataricum, respectively. The largest and the lowest tree crown diameters were achieved for Acer platanoides 'Olmsted' and for Magnolia kobus, respectively. The best and the worst trunk statuses by 2017 were achieved for Pyrus calleryana 'Chanticleer' and for Crataegus x lavalleei, respectively. The best and the worst tree crown statuses by 2017 were achieved for Pyrus calleryana 'Chanticleer' and for Acer tataricum, respectively. The best estimated tree viability status was achieved for Pyrus calleryana 'Chanticleer' and for Acer platanoides. Overall tree values were 2.73 times higher in 2017 compared to 2009. In conclusion, this study clearly demonstrated the importance of appropriate choice of tree taxa for an establishment of tree-row system in narrow street conditions.

Keywords: *tree-row system, tree measurements, green urban space*

INTRODUCTION

In general, urbanization is the increasing numbers of cities and citizens coupled with the spreading of city culture and lifestyle. More than half of the world human population lives in cities. This will increase in the future especially in those countries where large cities and metropolises grow dynamically. Viable urban environment is largely dependent on the size, condition and distribution of urban green spaces within and around the cities. One of the most essential elements of urban green spaces are the tree-rows in streets. In this system, trees usually planted along roads, railways, rivers and paths in rows. They have the most frequent connections with the citizens. On the other hand, tree-row systems are in the worst ecological conditions as well as the most difficult to repair compared to other urban green spaces (Schmidt 2003).

Tree species have to have special biological and ecological features if they are decided to plant in cities. The trees have to i) grow fast, ii) have long life ability, iii) have linear trunk, iv) have strong root system, v) have aesthetic value, vi) have cheap tree maintenance and vii) adopt the city various ecological conditions (e.g. air pollution, road salting, small living space). There are advantages of tree species with small leaves and early leaf growth (Schmidt 1988).

There are several professional books which describe tree species suitable under city circumstances in Hungary (Nagy 1980, Schmidt 2003, Schmidt and Varga 2004, Schmidt and Tóth 2006, Szabó 2015). Available tree taxa for city circumstances increased to double from the 1990's until 2004 in the market (Schmidt and Tóth 2006). Lists of tree rows in public domain are published yearly by the Hungarian Ornamental Gardener Association (Szaller 2013, 2017; Szabó 2015).

In Debrecen, trees live in disadvantageous ecological environment in the city centre. Their living spaces are narrow due to urban built environment both above and under the soil surface. Above the surface, the walls of the buildings and several civil engineering infrastructures limit growth of the tree trunk and crown. Under the surface, public utility system in the soil reduces root growth and road salting and chemical emission decrease viability of the tree root system. In addition, water and air supplies in these soils are inconsistent due to pavements of roads. These negative effects are stronger on trees planted in narrow streets.

The aim of this study was to evaluate tree taxa compositions and lifespan values of trees in tree-row system with special reference to five narrow streets of Debrecen.

MATERIALS AND METHODS

The study was performed in the centre of Debrecen, Eastern-Hungary, selecting five typical narrow streets with single-storey houses. The selected streets were Garai, Jókai, Tanító, Csokonai and Zsák (*Figure 1*).

Figure 1: **Physical map for trees on the selected streets (Garai, Jókai, Tanító, Csokonai and Zsák) for evaluating tree-row system in narrow streets of Debrecen**

In these streets, tree-row system was established in the 1930's with the direction of Ferenc Pohl. The tree species was *Celtis occidentalis.* These trees become old and weakened by the new century therefore trees replaced with new young trees. In 2009 and 2017, this newly established tree-row system was evaluated by the modified methods of Radó (1981, 1999). Observations were made in all selected streets and on all trees in both years.

First tree numbers and tree taxa were identified. Then the origin of tree taxa was established as native, alien or similar to native taxa. Similar to native taxa means those tree taxa which live similar ecological conditions like native tree taxa. Then six selected taxa (*Pyrus calleryana* 'Chanticleer', *Acer tataricum, Sorbus intermedia* 'Browseri', *Magnolia kobus, Acer platanoides* 'Olmsted', and *Crataegus* x *lavalleei* 'Carrierei') were further estimated for the following lifespan parameters: i) trunk diameter (cm), ii) tree crown size (m), iii) trunk status (in 0–5 grades), iv) tree crown status (in 0–5 grades), v) estimated tree viability (in 0–5 grades), and vi) tree value in Ft. Trunk diameter was measured 1 m above the surface. Trunk status represents the health and vitality of the trunk in a five grade scale. Tree value was calculated based on tree age, trunk diameter, and the grades of trunk and tree crown status. In case of parameter iii-vi) a 5 scale grading system was used in which grade 1 represented weak, grade 2 middle-weak, grade 3 middle, grade 4 good, grade 5 excellent features of the observed parameter.

RESULTS

In the five evaluated narrow streets, the numbers of tree taxa were 9 and 11 in 2009 and 2017, respectively (*Table 1*). Numbers of trees within the taxa varied from 3 to 68 and from 3 to 52 in 2009 and 2017, respectively. Total numbers of trees was similar in both years (279 in 2009 and 282 in 2017).

Numbers of some tree taxa changed during the 8 years due to some reasons. In case of *Malus prattii* 'Professor Sprenger', trees were not able to adopt the environment and they had to replace with new taxa. These taxa are not suitable to plant in the centre of Debrecen in narrow streets. In case of *Pyrus calleryana* 'Chanticleer', tree numbers were increased by 2017 as trees are well suited the ecological conditions of Garai street. Numbers of *Acer tataricum* did not changed, showing a good ecological adaptability of the taxa. Several trees of S*orbus* and *Magnolia kobus* taxa died in Csokonai and Jókai streets, respectively, indicating that these taxa are not really suitable in narrow streets. Overall the numbers of *Acer platanoides* also increased.

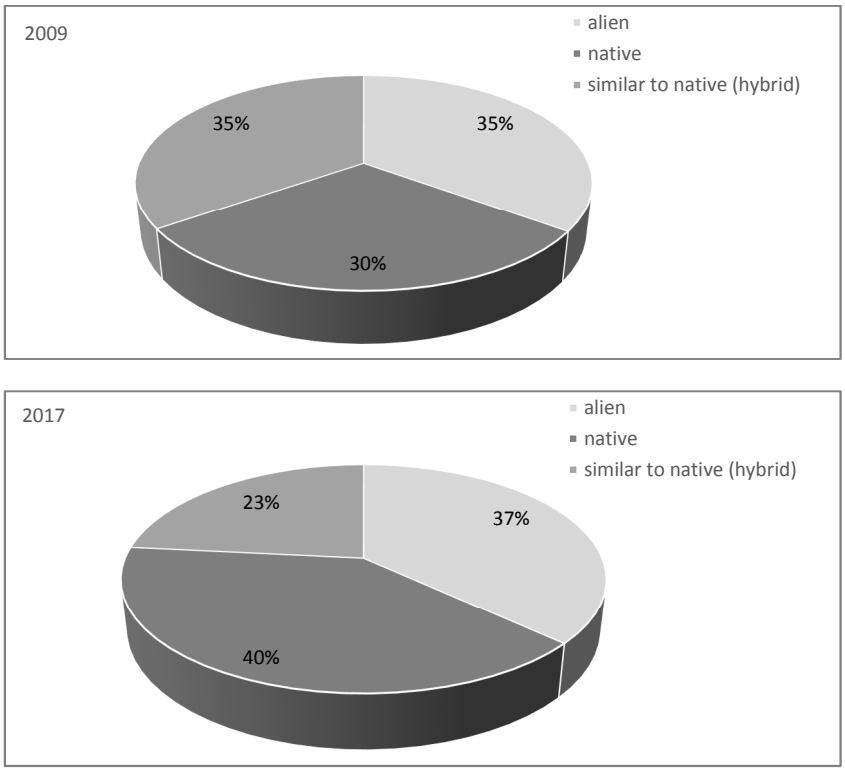
In 2009, 30% of the trees were native and 35% was similar to native taxa while the alien taxa were 35%. In 2017, the native taxa increased to 40% while 37% and 23% of the trees belonged to alien and similar to native taxa, respectively (*Figure 2*).

Table 1

Tree taxa and mean values of tree value in Ft and number of trees in 2009 and 2017 for the 5 evaluated streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen

Tree taxa	Tree value in Ft 2009	Tree number 2009	Tree value in Ft 2017	Tree number 2017
1. *Pyrus calleryana* 'Chanticleer'	416 000	26	1 545 600	30
2. *Acer tataricum*	34 000	17	1 022 200	17
3. *Sorbus intermedia* 'Browseri'	572 000	34	1 375 400	31
4. *Magnolia kobus*	1 113 000	59	2 531 200	51
5. *Acer platanoides* 'Olmsted'	1 232 000	68	2 573 200	52
6. *Acer platanoides*	-	-	932 400	21
7. *Acer platanoides* 'Columnare'	-	-	484 800	22
8. *Crataegus x lavalleei* 'Carrierei'	300 000	20	1 756 800	35
9. *Malus prattii* 'Professor Sprenger'	817 000	43	-	-
10. *Thuja occidentalis* 'Smaragd'	-	-	204 000	4
11. *Juniperus virginiana*	76 800	3	173 400	3
12. *Prunus serrulata*	81 600	3	153 000	3
mixed direct planting	91 160	5	170 200	3
mixed weed tree	17 000	1	50 720	10
Overall	4 750 560	279	12 972 920	282

Figure 2: **Origin of tree taxa (alien, native, similar to native-hybrid) in the 5 evaluated streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen in 2009 and in 2017**



Trunk diameter of the six tree taxa ranged between 4.9 and 9.8 cm and between 8.9 and 16.6 cm in 2009 and 2017, respectively (*Figure 3*). The largest and the lowest trunk diameters were achieved for *Pyrus calleryana* 'Chanticleer' and for *Acer tataricum*, respectively. The taxa of *Acer tataricum*, *Magnolia kobus* and *Crataegus x lavalleei* had significantly lower trunk growth during the 8 years compared to *Pyrus*, *Sorbus* or *Acer platanoides* species.

Tree crown diameter of the six tree taxa ranged between 0.66 and 1.5 m and between 2.4 and 3.7 m in 2009 and 2017, respectively (*Figure 4*). The largest and the lowest tree crown diameters were achieved for *Acer platanoides* 'Olmsted' and for *Magnolia kobus*, respectively. Most taxa produced twice to three times larger tree crown in 2017 compared to that of in 2009 with the exceptions of *Magnolia kobus* and *Crataegus x lavalleei*.

Trunk status of the six tree taxa ranged between 4.95 and 5.0 and between 3.7 and 4.9 cm in 2009 and 2017, respectively (*Figure 5*). The best and the worst trunk statuses by 2017 were achieved for *Pyrus calleryana* 'Chanticleer' and for *Crataegus x lavalleei*, respectively. All other taxa showed a significantly worse trunk status during the 8 years compared to *Pyrus calleryana* 'Chanticleer' species.

Figure 3: **Trunk diameter of six selected tree taxa in five narrow streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen in 2009 and 2017**

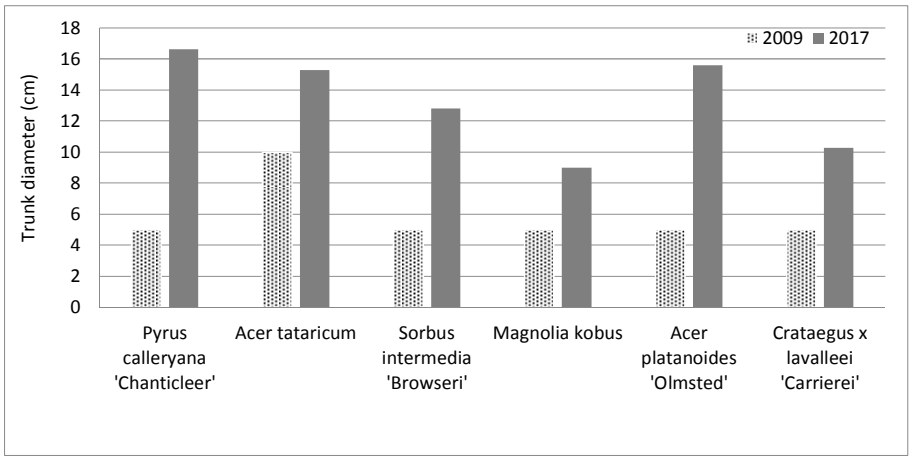


Figure 4: **Tree crown diameter of six selected tree taxa in five narrow streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen in 2009 and 2017**

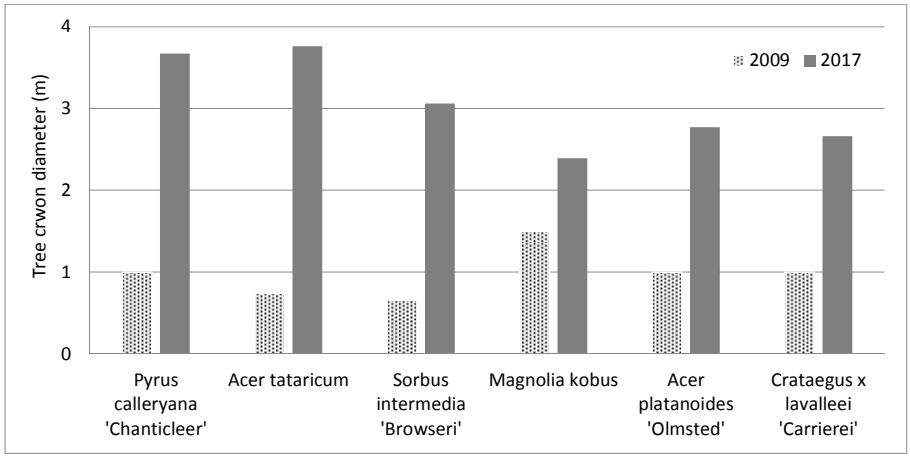
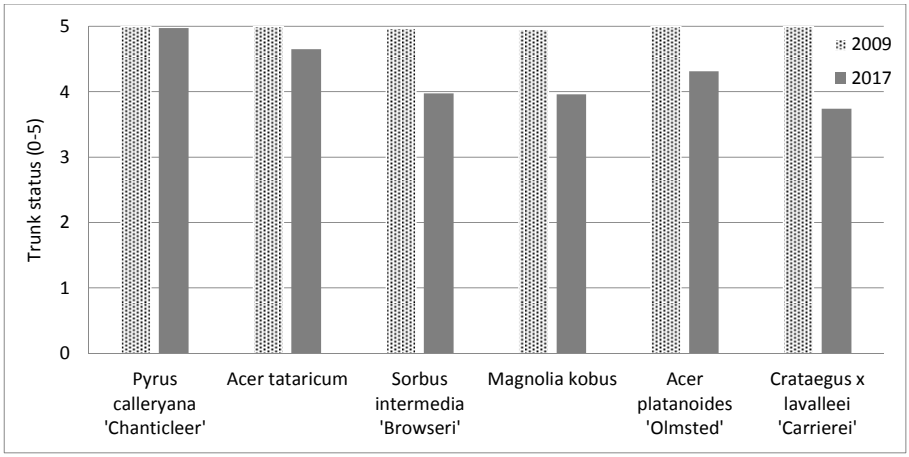


Figure 5: **Trunk status of six selected tree taxa in five narrow streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen in 2009 and 2017**



Tree crown status of the six tree taxa ranged between 4.9 and 5.0 and between 3.4 and 4.7 m in 2009 and 2017, respectively (*Figure 6*). The best and the worst tree crown statuses by 2017 were achieved for *Pyrus calleryana* 'Chanticleer' and for *Acer tataricum*, respectively.

Estimated tree viability of the six tree taxa ranged between 2.0 and 3.0 and between 3.7 and 4.8 m in 2009 and 2017, respectively (*Figure 7*). The best estimated tree viability status was achieved for *Pyrus calleryana* 'Chanticleer' and for *Acer platanoides*.

Figure 6: **Tree crown status of six selected tree taxa in five narrow streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen in 2009 and 2017**

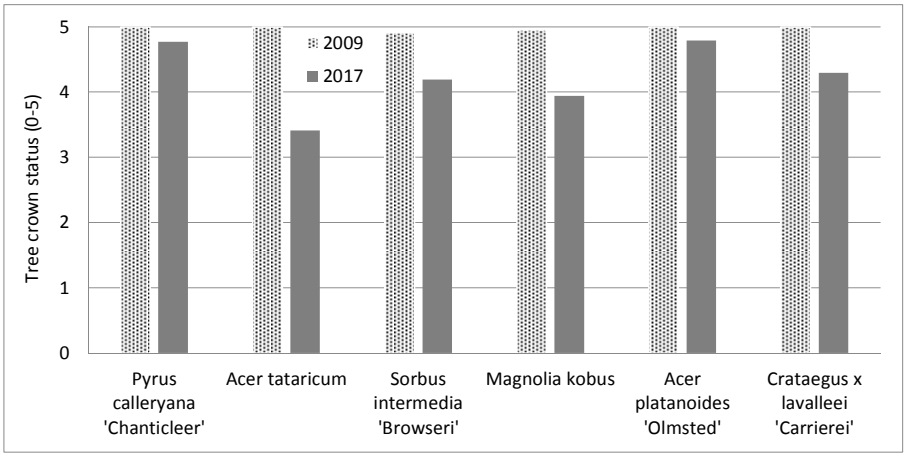
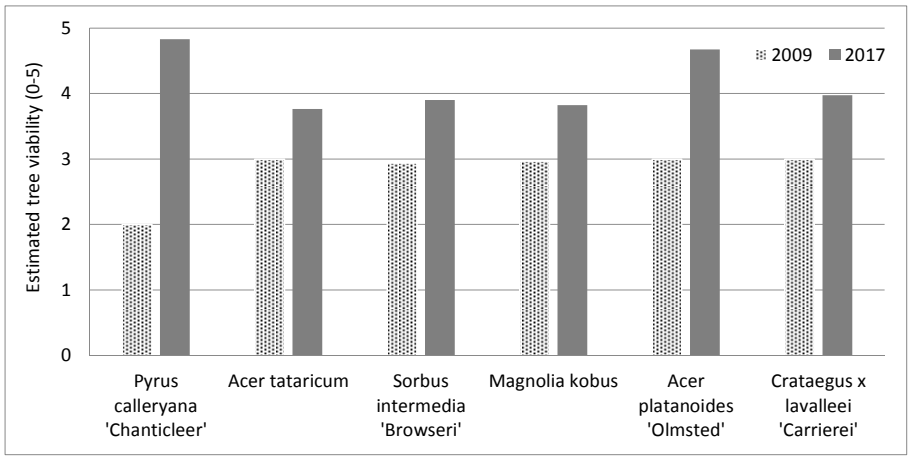


Figure 7: **Estimated tree viability of six selected tree taxa in five narrow streets (Garai, Jókai, Tanító, Csokonai and Zsák) in Debrecen in 2009 and 2017**



Tree values are greatly increased for each taxon from 2009 until 2017 (*Table 1*). Overall tree values were 2.73 times higher in 2017 compared to 2009 (4 750 560 Ft and 12 972 920 Ft, respectively).

CONCLUSION

This study evaluated tree species compositions and tree lifespan in a tree-row system for narrow streets of Debrecen. The study showed that *Pyrus calleryana* 'Chanticleer' and *Acer platanoides* were the most successful taxa among the evaluated six taxa for a tree-row system under urbanized conditions. This study clearly demonstrated the importance of appropriate choice of tree taxa for an establishment of tree-row system in narrow street conditions. Our study emphasizes the role of tree-rows as green surfaces in complex environmental improvement.

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