Estimation of Adaptability of Tree Species on the Basis of Tree Condition and Human Activities

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Abstract

This paper is dealing with the management of trees in the adverse conditions created by pollution and ecological particularities in the urban environment. The research took place in park of the University Campus of Thessaloniki. The research area is characterized by a semiarid mediterranean climate. To carry out the research, 2121 trees were numbered and the following works were done: description of the condition of health and vigor of each tree in the park area, recording of human activities which have affected the growth of trees, estimation of the adaptability of the tree species. The results of the research have shown that the species in the University Campus present the following problems: apparent signs of insect or disease, dense spacing, restricted root space, damages on trunk (fluid secretion, damages caused by illegal pruning, decay spots), partial crown necrosis, susceptibility to the winds. The pruning, even though systematically applied, are a forceful handling which cannot be tolerated by all tree species as *Hybiscus syriacus*, *Albizia julibrissin*, *Acer negundo*. Heavy insect attacks were observed on *Pinus brutia* and *Pinus halepensis* but not on *Pinus pinea* which presents the best development among the species of genus Pinus. All species have fluids on the trunk, because of mechanical injuries, being more frequently in *Acer negundo*, *Populus nigra var pyramidalis*, *Prunus cerasifera*. The species of *Platanus hybrida* and *Populus euroamericana* because of their extending surfaced root system and the lack of sufficient space causing the lifting of pavement tiles. *Cupressus sempervirens* has the best development among the species with pyramid-shaped crown and *Ligustrum vulgare* among the ones with round crown. The genus *Populus* appear the minor resistance against the wind. *Populus alba hybrida* is the most tolerant poplar species to the conditions of Thessaloniki.
1. Introduction

The ecological particularities of a city create adverse conditions for the trees growing within. The conditions are created by the pollution, mainly by air pollutants, the changes of the environmental factors and the human activities.

The air pollutants by the fluctuations they present in the space and time, are probably the most important permanent factor affecting the growth and the survival of plants within the urban environment (Kozlowski, 1986). The impacts of pollution upon the plants are usually becoming visible as white or colorful spots on leaves and fruits or burnt, dry, dead areas which are finally cut-off by the lively tissues of the plant leaving coarse ends or holes on trees. The induction of air pollutants into the inner environment of the plant may take place through the sprout, the roots and the leaves. The plants are protected against the air pollutants by layers of cells which obstruct their direct induction. So, tissues such as of sprouts are rarely affected. However, the roots are normally co-exist with fungi which increase and facilitate the intake of water and nutrients. When the air pollutants are affecting the physiological balance of carbohydrates of the roots the cohabitation is disturbed and the growth of roots becomes adverse (Treshow & Franklin, 1989). The flow of pollutants into the interior of the leaf may be obstructed by physical structures of the leaf (such as the presence of hairs etc.) or by competitive chemical reactions. Additionally, the amount entering a leaf depends on the amount of air which comes in contact with the leaf surface.

The environmental factors which are changing in the cities are climatic (temperature, air humidity, wind) and soil ones (small water availability, soil artificially created, alkaline pH) and in conjunction with the air pollution they set out the productivity, the growth and the survival of trees (Grey & Deneke, 1986; Dafis, 1993; Dafis, 1997).

The human interference (activities) are causing damages to trees either by various works which generate restrictions to the growing space of the aboveground
and underground part of trees or by wounds on the stem, resulting to the development of diseases which prevent their survival and growth.

For a rational management, treatment and care of trees within an urban environment, particularly in alleys, in parks, in squares etc., the full recording of all information about the existing trees, and the tilling mediums which are taken from time to time (crown looseness, pruning, wound treatments, disease fighting etc.), is required. Yet, by the above, a register book for trees of each area will be drawn out, a fact that will make easy the timely and right interference in city trees and the taking of necessary measures to meet the purpose of their planting.

The purpose of this research was: (1) the description of the condition of health and vigor of each tree in the park area under the unfavorable conditions due to the pollution and the ecological particularities in the urban environment (lack of desirable shape because of insects and diseases), (2) the recording of human activities which have affected the growth of trees (inappropriate position in park or alleys, lack of sufficient space for growing crowns and roots or mechanical injuries of the trunk, (3) the estimation of adaptability of the tree species.

2. Study area

The research was conducted in the park of the Aristotle University Campus in the City of Thessaloniki which is one of the few green areas left in the center of the city, occupying an area of 43 ha. Thessaloniki is located in Central North Greece and is built in the Thermaikos Gulf in longitude 22° 53’ and latitude 40° 34’.

The climate of the city is mediterranean with clear features of continental climate throughout the year. The temperature reaches the highest scores in July and the lowest in January. The annual temperature amplitude exceeds 20 °C. According to data of the University’s Meteorological Station, the average annual air temperature is 15.56 °C, the lowest average annual temperature is 5.5 °C (January), and the highest 25-26.5 °C (July). The absolute maximum temperature has reached 42 °C whereas the minimum -10 °C. The sunlight hours range between 2400-2600. The annual rainfall is 414 mm. The average relative humidity is 66.7% The snowfalls inside the city is not a rare phenomenon. The direction of winds varies depending on the season. In
winter, blow north winds originating from the valley of Axios river (Vardaris). In spring, S, SW winds (sea breezes) are blowing more often. In summer, blow N, W and SW winds; the former ones are caused by the Etesians and the latter ones by the sea breeze. In September, prevail the SW and from November N and W winds again. In Thessaloniki a constant decrease of stormy days is observed. This is ought to the fact that the city is continuously rising in size and height resulting in the creation of friction and anodic currents which reduce the wind’s velocity. In autumn 1998 on November 23rd at 11.00-12.00 a.m., winds blowing with 53 Km/h (=7 Beaufort) have caused the falling of many trees at the University Campus. The wind’s velocity scores in the greater region of the city and mainly in open air locations were higher than those measured in the University’s Station, the location of which is relatively protected by the University buildings.

From measurement results obtained in the period 1990-1996 in the nearest to University Campus station, it can be noticed that:

- Smoke presents a small increase during the last two years especially in central stations
- The SO₂ presents stability trends (50 mg/m³)
- The NO₂ presents a decreasing trend except in the station of the center of the city where a slight increase is recorded
- The Ozone presents a stability trend (45 mg/m³)
- The CO presents stable scores (2 mg/m³)
- The total suspended particles show small reducing trend (170 mg/m³).
- The SO₂, the smoke, the CO, the NO₂ and the suspended particles show bigger scores in winter whereas in summer higher ozone scores are recorded.
- During the week the higher scores for the above mentioned pollutants are occurring from Monday to Friday except for the ozone.
- During day and night, the higher scores for SO₂, NO₂ and CO, are written down in morning hours between 8.00 and 13.00 and in evening hours between 20.00 and 23.00 (due to car traffic), in contrast with ozone the higher scores of which occur between 13.00 and 17.00.

The soil in University Campus originates mostly from the mother rock and less from soil transport, fertilizers and manure. The subsoil had been formed during the Quaternary and specifically the Holocene. They are undivided coastal
depositions (sand and gathering) of red clay with lime which are alluviums of Axios and Gallikos rivers and torrents as well. The base is formed by conglomerates (glued rounded pebbles). The physical properties of the soil are closely depending on the location and the human activities. The pH of the upper soils layers is high a fact which is ought to the use of limestone gravel for the road surfacing.

3. Methods

To carry out the research, 2121 trees were numbered twice a year. The first check has taken place after the fall of leaves in autumn and the second one after the sprouting in May or June. For this aim the following works were done:
- Description of the condition of health and vigor of each tree in the park area. During checking out, apparent signs of insect or disease, dense spacing, damages on trunk (fluid secretion, damages caused by illegal pruning, decay spots), partial crown necrosis (induced of water deficiency and secondary diseases), susceptibility to the winds were recorded (Grey and Deneke, 1986; Dafis, 1997). Special attention was given to any decay spots, fungi infestations and branch breaking.
- Recording of human activities which have affected the growth of trees (mechanical injuries, pruning and illegal pruning, cover and restriction of root system by cement, asphalt and pavement tiles).
- Estimation of the adaptability of the tree species.

4. Results

In the University Campus a great variety of native and exotic trees can be found which are either single or they form tree groups or alleys. The municipality of Thessaloniki has the authority and the responsibility of tree species selection and methods of establishment in urban areas (Georgiadiou, 1995; Papadimas, 1995; Malamidis, 1995). Most of them and especially the fast growing species were planted many years ago and for this reason present many problems. The species which appear in the highest percentage in the park of the University Campus are the following (the species are in declining order): *Platanus hybrida*, *Populus alba*, *Ligustum vulgaris*,...
The results of the research have shown that the species present the following problems:

- Apparent signs of insect or disease (Conditions of health of tree) (Fig. 1.): *Pinus brutia* and *Pinus halepensis* (attack by *Thaumetopoea pityocampa*), *Prunus cerasifera*, *Populus nigra var. pyramidalis*, *Populus euroamericana*, *Sophora japonica*, *Acer negundo*, *Cercis siliquastrum*, *Populus alba*.

- Dense spacing (Fig 2): *Pinus brutia*, *Platanus hybrida*, *Laurus nobilis*, *Acer negundo*, *Albizia julibrissin*, *Ligustrum vulgare*, *Populus euroamericana*,

- Restricted root space (Extended surfaced root system and lack of sufficient soil space causing the lifting of pavement tiles) (Fig. 3): *Platanus hybrida*, *Populus euroamericana*, *Populus alba*, *Acer negundo*.

- Damages on trunk:
  a. Fluid secretion (Fig.4): *Prunus cerasifera*, *Acer negundo*, *Populus nigra var. pyramidalis*, *Pinus pinea*, *Cupressus sempervirens*, *Hibiscus syriacus*, *Populus euroamericana*, *Cupressus arizonica*.
  b. Damages caused by illegal pruning (Fig. 5): *Hybiscus syriacus*, *Albizia julibrissin*, *Pinus pinea*, *Populus euroamericana*, *Populus nigra var. pyramidalis*, *Prunus cerasifera*, *Acer negundo*, *Populus alba*, *Sophora japonica*.
  c. Decay spots (Fig.6): *Albizia julibrissin*, *Populus euroamericana*, *Sophora japonica*, *Cercis siliquastrum*, *Acer negundo*.

- Partial crown necrosis (induced of water deficiency and secondary diseases) (Fig. 7): *Populus euroamericana*, *Populus alba*, *Populus nigra var. pyramidalis*, *Platanus hybrida*.

- Susceptibility to the winds (Fig. 8): *Populus nigra var. pyramidalis*, *Populus euroamericana*, *Populus alba*, *Cupressus arizonica*.

5. Discussion and conclusions
- The pruning, even though systematically applied, are a forceful handling which cannot be tolerated by all tree species as *Hybiscus syriacus*, *Albizia julibrissin*, *Acer negundo*. Consequently they result to the creation of trunk and brunch decay by insect and fungi attacks, the trunk distortions like branch tufts and generally the prevention of the tree development.

- A huge insect attack was observed on *Pinus brutia* and *Pinus halepensis* but not on *Pinus pinea* which presents the best development among the species of genus Pinus.

- All kinds of trees have fluids at the trunk, because of mechanical injuries being more frequently in *Acer negundo*, *Populus nigra* var. *pyramidalis*, *Prunus cerasifera*.

- The species of *Platanus hybrida* and *Populus euroamericana* because of their extending surfaced root system and the lack of sufficient space cause the lifting of pavement tiles.

- *Cupressus sempervirens* has the best development among the species with pyramid-shaped crown and *Ligustrum vulgare* among the ones with round crown.

- *Prunus cerasifera* presents extended damages of the trunk like internal cavities and fissures in almost all individuals.

- *Laurus nobilis* individuals are more or less coppice origin. For this reason almost all trunks presents decay spots and they lack the necessary space for their normal growth.

- Because *Platanus hybridus* grows fast and no appropriate planting method is applied, its root system is covered by cement, asphalt and pavement tiles.

- *Cupressus arizonica* is an especially impressive species in young age. However, in older age presents reduced vigor and sparse crown with direct impact on its aesthetic picture. Due the surface rooting system which is restricted in the conditions of urban environment but also the dense, impermeable against the wind crown, the *Cupressus arizonica* show reduced resistance to the wind. For the above reasons many windfalls of this species occur during the storm.

- The genus *Populus* appear the minor resistance towards the wind. *Populus alba* has the best tolerance to the conditions of Thessaloniki (the best development of genus *Populus*, shortage of stress during the summer because of the drought e.t.c.). However, it is a very big tree which needs a large sufficient space for growing, a thing which has not been taken into consideration during its planting. Having as a result the outside crown development, leaning trunk and limited root system with negative affection of their tolerance to the external influences. A disadvantage of the species is
the maintenance of their leaves till the beginning of winter because of the impact of the lamp posts, a fact that makes them less tolerant to the winds. Therefore, this species must only be planted in open spaces without restrictions to the crown as to the roots as well male clones (P. alba var. spartiatica) which do not produce “cotton”. 

*Populus euroamericana* shows serious problems because of the high demands on water, for this it should be excluded not only from Thessaloniki but from the whole Greece generally. These trees fall their leaves prematurely during the summer and a lot of branches mortify and fall down and taking a risk human lives and properties. The fact that these trees were without leaves at the time of the storm had as a result the reduction of the windfalls. In addition these trees produce “cotton” which is an acute problem during Spring. *Populus nigra* var. *pyramidalis* can be used in suitable chosen position because of its columnar shape. The big number of windfall trees is owed to the fact that the individuals were restricted and they were infected especially by fungi.

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**References**


Fig. 1. Percentages of each tree species with insect or disease damages

Fig. 2. Percentage of each tree species growing in dense of spacing
Fig. 3. Percentage of each tree species with insufficient root space causing the lifting of pavement tiles.

Fig. 4. Percentage of each tree species with damages on trunks.
Fig. 5. Percentages of each tree species with damages on trunks caused by illegal pruning

Fig. 6. Percentages of each tree species with damages on trunks
Fig. 7. Percentage of each tree species with partial crown necrosis induced by water deficiency and secondary diseases.

Fig. 8. Percentage of windfalls of each tree species during the storm of 23rd November 1998.