

Original Article

Interrelations between the concentrations of SO₂, NO_x from the atmospheric air and S and N from leaves of forestry species. Part 1. Investigations based on data collected in 2010

VIMAN Oana¹, Ioan OROIAN^{2*}, Ioan Valentin PETRESCU-MAG²¹Faculty of Horticulture, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Manastur, 400372 Cluj-Napoca, Romania²Faculty of Agriculture, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Manastur, 400372 Cluj-Napoca, RomaniaReceived 8 September 2015; received and revised form 30 September 2015; accepted 30 October 2015
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Abstract

The point of the present research was to find possible interrelations between the concentrations of SO₂, NO_x from the atmospheric air and S and N from leaves of forestry species. The samples, respectively the leaves and the needles, have been collected from six trees, from four stations of air quality control within Cluj-Napoca, the trees being represented by different woody species, that have been identified around the stations. The samples have been collected at the end of September, 2010. The majority of the species taken under discussion in case of monitoring stations are strongly to very strongly susceptible to the risk of the expression of physiological diseases as a result of the exposure to nitrogen oxides from the atmospheric air, due to their large capacity of nitrogen accumulation in leaves. The most exposed are *Pinus nigra*, *Picea pungens* var. *glauca* and *Tilia cordata*, the less exposed is *Aesculus hippocastanum*, whereas *Betula pendula* is situated on an intermediary position.

Keywords: leaves, needles, SO₂, NO_x content, atmospheric air, Cluj-Napoca.

1. Introduction

Air pollution can cause death, impair health, reduce visibility, bring about vast economic losses and contribute to the general deterioration of both our cities and countryside [3]. It can cause intangible losses to historical monuments.

It is, therefore, a matter of great importance that engineers of all fields of activity consciously incorporate in their design, sufficient constraints and safe measures, to ensure that they do not contribute to atmospheric pollution [5].

In terms of repetitive measurement of one or more atmospheric constituents, quantity and quality, air quality control is an observational process [7].

Several issues of global importance are connected to air quality, and among these, we can mention: identification of polluted areas, comparisons of real time values, of air presumptive pollutants, with recommended values, established by national and/or international regulations, or air quality indicators [6, 7].

In this respect, we can mention that all data resulted from the air quality monitoring networks make possible the adoption and implementation of appropriate and urgent actions for fight against air pollution [7].

* Corresponding author.
Fax: +40-264-593792
Tel: +40-264-596384
e-mail: neluoroian@gmail.com

An important objective of air pollution networks involves the correct positioning of the infrastructure destined to surveillance of the air quality [7]. Thus it must supply the recording of all

In Romania, the air quality assessment is carried out on basis of emission inventories, but also taking into account the meteorological data; in this respect, mathematical models are used in order to assess the pollution dispersion in the atmosphere [7]. At national level, the studies concerning the evaluation of the air quality are conducted with respect of specific legislation, consisting from a series of laws, ordinances and governmental decisions [6, 7]. In order to elaborate and implement the necessary plans and programmes of air quality management, the identification of areas affected by moderate and or intense pollution, is needed. In this way, successful practices may be implemented in order to reduce pollution under the limit values in an appropriate time span [1, 7].

The assessment of the pollution degree of ornamental trees from urban spaces needs the exact identification of affected areas. In this way, a first step is made in order to overcome the possible overrun of limit values of the concerned species [7]. This action has a key role in the identification of possible pollutants with harmful effects upon trees.

These factors may influence the disease etiology of the ornamental trees commonly used in urban spaces [7].

The assessment of the influence of gaseous substances with pollutant potential, which are present in air (SO_2 and NO_x), upon physiological disease etiology expressed by forestry species characteristic to urban spaces represented the aim of a previous research, conducted by Viman, in 2012 [7], where the quantification of the contamination degree with nitrogen oxides and sulphur dioxide of some ornamental trees species characteristic to urban spaces and the evaluation of the influence of these pollutants in physiological disease etiology manifested by the forestry species was presented [7]. In a previous research, we aimed to identify the foliar symptoms of pollution and the SO_2 and NO_x content of leaves, in Cluj-Napoca town, taking into account the intensity and way of pollution [7], and we found that their effects on trees are more intense on leaves, which is the organ with the highest susceptibility at air pollution. Similar results we obtained when soil samples from monitored area were analyzed, because soil has large surface of contact with the environment [2, 7].

The objective of the present research was to find (if any) interrelations between the concentrations of SO_2 , NO_x from the atmospheric air and S and N from leaves of forestry species.

types of possible air pollutants that can be result of the emissions from traffic, industry, heating (of commercial places and/or houses), etc. [4, 7].

2. Material and Method

Monitoring of the air quality occupies a very important role within the system of environmental monitoring techniques [2, 7]. Because atmosphere is the largest vector in the propagation of pollutants, it must receive special attention from both scientist and local authorities.

The pollutant effects of the atmosphere affect both local levels, and global levels, influencing all environment, with its biotic, and abiotic components.

In our research, we followed the same protocol as in research we conducted in previous years [7], involving the collection of leaves from the inferior, middle and superior part of trees and laboratory analysis for testing the possible presence of nitrogen and sulphur in increased contents, over legal limit.

The following fixed monitoring stations of air quality are being placed in Cluj-Napoca town:

- monitoring station CLU-1, type traffic, situated in the bus station from Aurel Vlaicu Street, in the neighborhoods of OMV gasoline station;
- monitoring station CLU-2, type urban, situated in the inner yard of the Nicolae Bălcescu Highschool (Liceul Nicolae Bălcescu);
- monitoring station CLU-3, type suburban, situated in Grigorescu (Cartier Grigorescu), on the 1st December 1918 Boulevard (B-dul 1 Decembrie 1918), near RATUC garage;
- monitoring station CLU-4, type industrial, situated in the north-eastern side of Cluj-Napoca, on Dâmboviței Street, within Expo Transilvania yard.

Two pannels have been installed in order to inform the public upon air quality monitoring stations: the exterior pannel is situated in Mihai Viteazu Market (Piața Mihai Viteazu), near the Agroindustrial Hall (Hala Agroalimentară); the interior pannel is situated within the Cluj-Napoca City Hall, on Moșilor Street [7].

The samples, respectively the leaves and the needles, have been prelevated from six trees (A1 - A6) from four stations (CLU-1; CLU-2; CLU-3; CLU-4) of air quality within Cluj-Napoca town, the trees being represented by different forestry species, that have been identified around the stations (see Table 1). The samples have been collected at the end of September, year 2010.

After smashing and weighing the samples with a Shimadzu scale one has worked with Berhof type equipment in the mineralization stage.

Table 1. Trees from the four stations: CLU-1 – CLU-4

Trees from station CLU-1 (A1-A6)	Trees from station CLU-2 (A1-A6)	Trees from station CLU-3 (A1-A6)	Trees from station CLU-4 (A1-A6)
<i>Pinus nigra</i> – Black pine	<i>Acer platanoides</i> – Norway maple	<i>Acer platanoides</i> – Norway maple	<i>Tilia cordata</i> – Small- leaved lime
<i>Aesculus hippocastanum</i> – Horse chestnut	<i>Acer pseudoplatanus</i> – Sycamore maple	<i>Acer platanoides</i> – Norway maple	<i>Tilia cordata</i> – Small- leaved lime
<i>Aesculus hippocastanum</i> – Horse chestnut	<i>Tilia cordata</i> – Small- leaved lime	<i>Juglans regia</i> – Nut tree	<i>Aesculus hippocastanum</i> – Horse chestnut
<i>Betula pendula</i> – Silver birch	<i>Tilia cordata</i> – Small- leaved lime	<i>Picea abies</i> – Norway spruce	<i>Aesculus hippocastanum</i> – Horse chestnut
<i>Picea pungens</i> var. <i>glauca</i> – Colorado blue spruce	<i>Acer platanoides</i> – Norway maple	<i>Robinia pseudoacacia</i> – False acacia	<i>Thuja occidentalis</i> – Northern white-cedar
<i>Tilia cordata</i> – Small- leaved lime	<i>Tilia cordata</i> – Small- leaved lime	<i>Tilia cordata</i> – Small- leaved lime	<i>Pinus nigra</i> – Black pine

3. Results and Discussion

Our research emphasizes that majority of the monitored species located in the vicinity of the monitoring stations (CLU-1 - CLU-4) are strongly to very strongly exposed to the physiological diseases risk.

This is the result of the air charge in SO₂ and NO_x, but also to their physiological traits, which allow these species a high capacity of nitrogen and sulphur accumulation in their leaves,

especially. *Pinus nigra*, *Picea pungens* var. *glauca* and *Tilia cordata* are the most exposed species, while *Aesculus hippocastanum* has the lowest accumulation capacity.

In the meantime, we mention that *Betula pendula* has a moderate accumulation capacity being also moderate exposed to physiological diseases produced by sulphur and nitrogen accumulations in the tree leaves (Tables 2 - 5).

Table 2. Interrelations between the concentrations of SO₂, NO_x from the ambient air, S and N from leaves of forestry species analyzed within station CLU-1 in year 2010, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Pinus nigra</i>	0.938	0.881
<i>Aesculus hippocastanum</i> 1	0.493	0.244
<i>Aesculus hippocastanum</i> 2	0.643	0.413
<i>Betula pendula</i>	0.997	0.994
<i>Picea pungens</i> var. <i>glauca</i>	0.582	0.339
<i>Tilia cordata</i>	0.564	0.319

Table 3. Interrelations between the concentrations of SO₂, NO_x from the ambient air, S and N from leaves of forestry species analyzed within station CLU-2 in year 2010, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Acer platanoides</i> 1	0.992	0.985
<i>Acer pseudoplatanus</i>	0.985	0.970
<i>Tilia cordata</i> 1	0.997	0.994
<i>Tilia cordata</i> 2	0.990	0.981
<i>Acer platanoides</i> 2	0.996	0.993
<i>Tilia cordata</i> 3	0.980	0.961

Table 4. Interrelations between the concentrations of SO₂, NO_x from the ambient air, S and N from leaves of forestry species analyzed within station CLU-3 in year 2010, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Acer platanoides</i> 1	0.987	0.975
<i>Acer platanoides</i> 2	0.973	0.947
<i>Juglans regia</i>	0.995	0.990
<i>Picea abies</i>	0.956	0.914
<i>Robinia pseudoacacia</i>	0.991	0.982
<i>Tilia cordata</i>	0.923	0.853

Table 5. Interrelations between the concentrations of SO₂, NO_x from the ambient air, S and N from leaves of forestry species analyzed within station CLU-4 in year 2010, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Tilia cordata</i> 1	0.538	0.289
<i>Tilia cordata</i> 2	0.493	0.244
<i>Aesculus hippocastanum</i> 1	0.643	0.413
<i>Aesculus hippocastanum</i> 2	0.497	0.249
<i>Thuja occidentalis</i>	0.564	0.319
<i>Pinus nigra</i>	0.882	0.779

4. Conclusions

The majority of the species taken under discussion in case of monitoring stations are strongly to very strongly susceptible to the risk of the manifestation of physiological diseases as a result of the exposure to nitrogen oxides from the atmospheric air, due to their large capacity of nitrogen accumulation in leaves. The most exposed are *Pinus nigra*, *Picea pungens* var. *glauca* and *Tilia cordata*, the less exposed is *Aesculus hippocastanum*, whereas *Betula pendula* is situated on an intermediary position. Thorough conclusions will be presented after the second year of investigations (using samples collected in 2011).

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