

Original Article

Interrelations between the Concentration of SO₂, NO_x from the Atmospheric Air and S and N from Leaves of Forestry Species. Part 2. Investigations Based on Data Collected in 2011

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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 and needles of forestry species. The samples have been collected from six trees, from four stations of air quality control within Cluj-Napoca (CLU-1 – CLU-4). The samples have been collected at the end of September, 2011. One realizes the fact that the forestry species analyzed present considerable differences in their susceptibility to the risk of manifestation of physiological diseases function of concentration of gaseous pollutants in the atmospheric air. In monitoring station CLU-1, at species *Betula pendula* one can observe the fact that even though none of the pollutants taken into consideration exceed the maximum allowable concentration in the ambient air, as a result of the interaction between these factors ($R = 0.997$), the manifestation of the physiological diseases is favoured, foliar lesions being noticed. In station CLU-2, at species *Acer pseudoplatanus* we can see that even though none of the pollutants taken into consideration exceed the maximum admitted concentration in the ambient air, due to the interaction between these, the manifestation of physiological diseases is favoured. This can be observed macroscopically on leaves, lesions being seen on the foliar surface. In station CLU-3, at species *Juglans regia* one notices the fact that even though none of the pollutants exceed the maximum allowable concentration in ambient air, as a result of the interaction between these ($R = 0.995$), manifestation of physiological diseases is visible. In station CLU-4, at species *Pinus nigra* one notices the fact that although neither SO₂ nor NO_x exceed the maximum allowable concentration in the air, as a result of the interaction between these two factors ($R = 0.882$), expression of physiological diseases in needles is favoured. This can be easily observed on the needles.

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

1. Introduction

Air pollution is a topic among many others, and it has been at the forefront of social concern for the last decades [5, 7].

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Urban air pollution is probably the most well known problem created by rapid industrialization.

Air pollution around major factories, thermal power plants, open mines and quarries has attracted a lot of attention [6].

Environmental protection strategies aim to overcome, if totally avoiding is not possible, the harmful effects of pollutants [8].

Their influence on both artificial and natural environment must be diminished by using specific pollutants detection techniques designed to identify the causes of pollution, but the final aim of implementation of environmental protection techniques consists in pollutants removal, in this way resulting the reduction of the pollution effects [2, 4].

In Romania, the concrete objectives of environmental protection are detailed established in taking into account the legislative package concerning the artificial and natural environment, together with their components [8]. If we take into account the components of the motorization of the air quality, we must mention "monitoring is the surveillance system of prognosis, warning and intervention that takes into account the systematical evaluation of dynamic characteristics of environmental factors, having as aim the knowledge of actual values of elements that pollute the environment" [8]. A comprehensive knowledge of the atmospheric pollution sources, as well as their dynamics is needed in order to formulate the most suitable environmental protection measures [3, 8].

At the basis of our research stays the sampling of leaves and needles from the inferior, middle and superior part of trees and laboratory analysis for the noxae content.

The research regarding the foliar symptoms of pollution and the noxae content of leaves was made in Cluj-Napoca town, under the aspect of intensity and way of pollution; data not shown in this paper; see Viman [8]. Generally, the effect of noxae on trees are more expressive on leaves, the organ with the highest susceptibility to air pollution, as well as on soil, due to its large surface of contact with the environment [1].

An important point concerning the assessment of the pollution extent in ornamental trees located in specific urban zones, consists in finding these zones and overcoming the possible overrun of limit values in concerned pollutants. It is an important issue for finding those factors that may be involved in pollution events that may have even important influence in the etiology of the physiological diseases affecting ornamental tree species.

The evaluation of the effect of gas pollutants from atmospheric air (SO_2 și NO_x) upon physiological disease etiology expressed by forestry species characteristic to urban areas were the aim of our previous set of studies (see detailed research in Viman [8]; where the determination of the degree of contamination with sulphur and nitrogen oxides of some forestry species characteristic to urban spaces

and the evaluation of the influence of these pollutants in physiological disease etiology manifested by the forestry species was discussed). The objective of the current research is to find (if any) interrelations between the concentrations of SO_2 , NO_x from the atmospheric air and S and N from leaves of woody species.

2. Material and Method

Monitoring of the air quality occupies an important role in assessing and maintaining environmental quality. In this context, we mention that atmosphere is "the most notable vector in the process of propagation of pollutants, whose effects are being felt at a local level, up to a global level, on all the biotic and abiotic parts of the environment [8]. In Cluj-Napoca the following fixed monitoring stations of air quality were chosen for this study: monitoring station CLU-1, type of station - traffic, situated in the bus station from Aurel Vlaicu Street, near the OMV gasoline station; monitoring station CLU-2, type of station - urban, situated in the inner yard of the Nicolae Bălcescu Highschool; monitoring station CLU-3, type of station - suburban, situated in Grigorescu, on the 1st December 1918 Boulevard, near RATUC garage; monitoring station CLU-4, type of station - industrial, situated in the north-eastern part of the town on Dâmboviței Street, within SC Expo Transylvania yard. Two panels were installed in order to inform the public upon air quality monitoring stations: the exterior panel was situated in Mihai Viteazu Market, near the Agroindustrial Hall; the interior panel was situated within the Cluj-Napoca City Hall, on Moșilor Street [8].

The smashing and weighing of the samples was made using a Shimadzu scale. A Berhof type equipment was used by the laboratory personnel in the mineralization stage.

The samples, respectively the leaves and the needles, have been collected from six trees (see A1 - A6 in Table 1) from the four stations of air quality control presented above (CLU-1, CLU-2, CLU-3, CLU-4). The trees are various forestry species which have been found near the stations (see details in Table 1).

The present study (2011) is a repetitive study of the research started in 2010; see the whole study in Viman [8]. The same vegetal species have been considered for investigation as in the case of our first study in the previous year, 2010. The vegetal samples (leaves and needles) have been collected in the second part of September, 2011.

Table 1. Trees from the air quality control 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 Discussions

According to our investigations using the multiple regression analysis, the studied species present various degrees of susceptibility to risks of manifestation of physiological diseases (see 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 2011, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Pinus nigra</i>	0.919	0.844
<i>Aesculus hippocastanum</i> 1	0.409	0.167
<i>Aesculus hippocastanum</i> 2	0.402	0.162
<i>Betula pendula</i>	0.925	0.855
<i>Picea pungens</i> var. <i>glauca</i>	0.573	0.329
<i>Tilia cordata</i>	0.581	0.337

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 2011, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Acer platanoides</i> 1	0.909	0.826
<i>Acer pseudoplatanus</i>	0.911	0.931
<i>Tilia cordata</i> 1	0.935	0.875
<i>Tilia cordata</i> 2	0.932	0.868
<i>Acer platanoides</i> 2	0.904	0.818
<i>Tilia cordata</i> 3	0.946	0.896

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 2011, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Acer platanoides</i> 1	0.950	0.903
<i>Acer platanoides</i> 2	0.967	0.936
<i>Juglans regia</i>	0.997	0.995
<i>Picea albies</i>	0.995	0.990
<i>Robinia pseudoaccacia</i>	0.998	0.996

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 2011, revealed by the multiple regression analysis

Tree species	R	R ²
<i>Tilia cordata</i> 1	0.519	0.269
<i>Tilia cordata</i> 2	0.409	0.167
<i>Aesculus hippocastanum</i> 1	0.402	0.162
<i>Aesculus hippocastanum</i> 2	0.425	0.181
<i>Thuja occidentalis</i>	0.573	0.329
<i>Pinus nigra</i>	0.881	0.778

4. Conclusions

Having in view the fact that the present study (2011) is a repetitive study of the research started in 2010, our conclusions must be comprehensive and it must include all the aspects investigated (2010-2011). Such a global vision should point the next conclusions.

One realizes the fact that the forestry species analyzed present considerable differences in their susceptibility to the risk of manifestation of physiological diseases function of concentration of gaseous pollutants in the atmospheric air. This is a result of the different abilities of accumulation of sulphur and nitrogen in leaves.

We find that SO₂ and NO_x concentration in ambient air nearby the monitoring station CLU-1 exceed the maximum limit of concentration. Thus, as a result of the interaction between the SO₂ and NO_x ambient air concentration and sulphur and nitrogen concentration in *Betula pendula* leaves (R = 0.997), the above mentioned monitored ornamental tree is exposed to the physiological diseases.

In vicinity of the monitoring station CLU-2, the SO₂ and NO_x concentration in ambient air does not exceed the maximum limit of concentration. Even though, as a result of the interaction between the SO₂ and NO_x ambient air concentration and sulphur and nitrogen concentration in *Acer pseudoplatanus*, due to the interaction between these, the manifestation of physiological diseases is favoured. This can be observed macroscopically on leaves, lesions being seen on the foliar surface.

In station CLU-3, in *Juglans regia* specie, we find that even none of SO₂ or NO_x concentration are over the allowed limit in ambient air, as a result of the interaction between these (R = 0.995) and concentrations in tree leaves, manifestation of physiological diseases is favoured. This can be easily observed on the foliar surface.

In station CLU-4, at species *Pinus nigra* one notices the fact that although neither SO₂ nor NO_x exceed the maximum allowable concentration in the ambient air, as a result of the interaction between these two factors (R = 0.882), expression of physiological diseases in needles is favored. This can be easily observed on the needles.

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