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ESTIMATION OF THE SANITARY STATE OF THE PINE TREES BY ELECTROPHYSICAL METHOD IN URBAN PLANTINGS OF YEKATERINBURG
(ОЦЕНКА САНИТАРНОГО СОСТОЯНИЯ СОСНОВЫХ ДЕРЕВЬЕВ ЭЛЕКТРОФИЗИЧЕСКИМ МЕТОДОМ В ГОРОДСКИХ НАСАЖДЕНИЯХ ЕКАТЕРИНБУРГА)

The scale estimation of sanitary state categories by using Electrophysical Method for pine Trees Urban Plantings of Yekaterinburg are presented in the article.

Представлена шкала оценки категорий санитарного состояния для деревьев сосны обыкновенной на основе электрофизического метода в насаждениях Екатеринбурга.

Introduction

At present the sanitary state of trees is generally assessed visually. The parameters to consider are crown condition, foliage (needle-foliage) condition, the degree of insect and phyto-infestation, physical damage, etc. Identifying these parameters is based on subjective perception rather than qualitative parameters.

It has been stated in specialist literature that one needs to develop more objective methods of tree health assessment. Among other things it has been suggested to assess the sanitary state by thermal and electrophysical parameters (Kashiro, 1970, Matorkin A.A, 2009, et al).

We believe that the electrophysical method is especially noteworthy. It is based on measuring electrical impedance of plant stem cambial zone. This parameter is mostly contingent on water content of tree organs. This method provides rather objective assessment of plants without damaging their tissues or breaking their ontogenically determined interaction.

Aim of the study

The research aims at developing a scale to determine tree sanitary state categories using electrophysical parameters which increase assessment accuracy and objectivity during the inventory of urban green space elements.

Materials and methods

The field research was conducted in natural pine stands located in various parts of Yekaterinburg (pocket parks, parks and woodland parks). The average age of pine forest ranges between 120 and 140 years. During Stage 1 sample trees of various sanitary states were selected in the stands under study. Their sanitary state categories were determined visually using a corresponding scale. There were the following categories: healthy trees (category 1), weakened trees (category 2), highly weakened trees (category 3), drying out trees (category 4), dead standing trees (category 5). To achieve the objective 107 sample trees were selected. Their sanitary state category distribution is shown on Table 1.

During stage 2 each sample tree was measured at four different frequencies (1kHz, 10kHz, 100Hz, 120Hz) to determine electrical impedance (R, ohm), an electrophysical parameter of the cambial zone, using the RLC Aktacom-3123 measuring device with a custom-made test probe at a height of 1.3 m above the butt at four cardinal directions. Before that, small 2 by 2-square-centimeter sample areas had been prepared. The test probe was stuck in about 13 mm deep. The distance between test probe contact points was 1 cm.

Discussion

While processing the experimental data we solved the following methodological problems:

1) Which cardinal direction is most suitable for measuring?

We analyzed data obtained by the RLC Aktacom-3123 measuring device at every frequency at four cardinal directions and found out that there is no correlation between cardinal directions and the parameters measured. Hence we may conclude that one can take measurements at any direction, but it ought to be the same with every tree at a given site.

2) Another methodological problem to solve was at which height and which frequency we are to take measurements.

For this we used the E7-25 immittance measurement device with a range between 25 hertz to 1000 kilohertz. The device works

Table 1

Sample trees distribution on various objects by grade of sanitary state

№	Location of objects of study	Number of user trees by grade of sanitary status				Total
		1	2	3	4	
1	Square (Mashinostroiteley street)	-	1	11	3	15
2	Kalinovskii WoodLand Park	3	13	1	2	19
3	Square (Iasnia street)	-	7	-	3	10
4	Shyvakishskii WoodLand Park	20	22	4	-	46
5	natural pine stand (district of Sortirovka)	-	1	12	1	14
6	natural pine stand district of Akademicheskii	-	1	2	-	3
	Total	23	45	30	9	107

in the automatic mode with a computer. Slide 10 shows this computer-supported operation. After the test probe contact points had been inserted in the bast all we had to do was run custom software so that the measuring device could read and record electrical impedance R and capacity C at recommended frequencies. Using the data obtained, hodographs were plotted in special program. The hodograph data and the data file analysis prove that the optimal measurement frequency is 10 kilohertz. We came to the conclusion that a frequency of 10 kilohertz is to be used for further research.

3) The next stage was to develop scale to determine tree sanitary state categories.

Using the STATISTICA 10 software the main statistical parameters were calculated: mean, standard deviation, variation coefficient, precision for electrophysical parameter R for all sanitary state categories (Tab. 2).

Analyzing the Tab. 2 we can conclude that there is a correlation between and sanitary state category, wood moisture content and electrical impedance R. The worse the tree sanitary state is, the higher the electrical impedance. That is why a preliminary sanitary state category assessment scale was developed using the electrophysical parameter R. The scale is shown on Tab. 3. Using the scale we can assume that the value of electrical impedance for category 1 trees is up to 7 kOhm, that for category 2 trees is between 7 and 11 kOhm, and that for category 3 trees is between 11 and 20 kOhm. Category 4 is assigned to trees with values over 20 kOhm.

Resume

The recommendations and the scale make it possible to determine with more accuracy sanitary state categories for pine trees. Further research can be conducted for other local species as well.

Table 2

Basic Statistics for Electrical Impedance

Sanitary state category	Basic Statistics for R, Ohm				
	mean value	standard deviation	min. value	max. value	precision of the experiment, %
1	6912	164	5600	8200	2.4
2	8756	267	7525	11500	3.0
3	11302	640	9275	15475	5.7
4	370499	9326	23575	3334490	2.5

Table 3

Preliminary sanitary state category assessment scale for pine trees by electrical impedance

Sanitary state category	Electrical impedance (R, Ohm)
1	less than 7000
2	7000-11000
3	11000-20000
4	over 20000

Literature

1. Kashiro Y.P. Electrometric method of estimation of survival in pine seedlings in artificial planting // Proceedings of the Institute of Plant and Animal Ecology. 1970, Vol. 67. The Academy of Sciences of the USSR. Ural branch. P. 294–300.

2. Matorkin A.A. Improving of selection methods of conifers trees by forming stand: Author. dis. ... cand. of agricult. sciences. Yoshkar-Ola, 2009. P. 23.

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УСТОЙЧИВОСТЬ ЛЕСНЫХ НАСАЖДЕНИЙ К АЭРОТЕХНОГЕННОМУ ЗАГРЯЗНЕНИЮ В ЗАВИСИМОСТИ ОТ СТРУКТУРЫ, ВОЗРАСТА, СОСТАВА ДРЕВОСТОЕВ И УСЛОВИЙ МЕСТОПРОИЗРАСТАНИЯ

(RESISTANCE OF FOREST PLANTATIONS TO AIR POLLUTION DEPENDING ON THE STRUCTURE, AGE AND SPECIES COMPOSITON OF FOREST STANDS AND SITE CONDITIONS)

Установлено, что устойчивость лесных насаждений к аэротехногенному загрязнению зависит от структуры, возраста, состава древостоев и условий местопроизрастания. Полученные данные свидетельствуют о значительном ухудшении состояния лесов под воздействием аэротехногенного загрязнения в неблагоприятные по климатическим условиям периоды. Устойчивость лесов к выбросам в это время снижается. В такие периоды, как правило, проявляется эффект так называемого «накопленного воздействия» в условиях хронического аэротехногенного загрязнения.

It was found that the stability of forest stands to air technogenic pollution depends on the structure, age and composition of stands and site condition . The obtained data confirm that in adverse climatic conditions significant deterioration of forests occurs under the influence of air technogenic pollution. Stands resistance to emissions is reduced during such periods. During such periods the effect of the so-called “accumulated impact” in conditions of chronic air technogenic pollution is found as a rule.

Исследования в районах крупных промузлов на Урале показывают, что под влиянием аэротехногенных выбросов развитие лесных насаждений сопровождается снижением их общего биологического разнообразия, продуктивности, а также упрощением структуры, изменением круговорота химических элементов. Наблюдается торможение как продукционных, так и деструктивных процессов. В зоне сильного поражения СУМЗа, например, насаждения находятся в V (последней) стадии дигрессии.

Условия местопроизрастания. На местностях с сильно выраженным рельефом, особенно в бореальных лесах, состояние кроны деревьев в значительной степени зависит от влияния ветров, поэтому предлагают при закладке ППП выделять четыре топографические положения:

1) вершина (верхняя часть холма, плато с уклоном менее 20^0);

2) склон (уклон более 20^0);

3) терраса или плоский склон (уклон менее 20^0);

4) равнина, долина и т.п. (Лесиньски, Армолайтис, 1992).

Исследования состояния еловолиственничных лесов и редколесий в зоне действия Норильского горно-металлургического комбината (НГМК) показали, что устойчивость древостоев зависит