

## BIOASSAY TECHNIQUES OF SOIL ECOLOGICAL STATUS ASSESSMENT NEAR THE AIRPORTS

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**Abstract.** Results of biological methods of an estimation of definition of toxicity of ground in territories adjoining to airports are presented. It is lead quality standard of a soil cover on biotests of different trophic levels. It is certain toxicity of ground in vicinities of airports.

**Keywords:** aviation processes; environment protection; environmental safety of airports; heavy metals; hydrocarbons; pollution.

### 1. Introduction

Nowadays biological monitoring takes leading positions in the field of research of the of natural environment state assessment. Application of this method for the environment diagnostics provides high credibility of results at the low price of investigations [Semenkova, Sokolova 2003; Klimenko 2006; Velichko, Zerkalov 2001].

The methods of biological assessment of natural components stability are lately increasing important as they are efficient and environmentally non-dangerous [Kipnis et al. 2002].

Biotesting plays an important role in the assessment of environment condition. It is conditioned by the fact that the results of chemical analysis, conducted with the help of complicated analytical equipment, in many cases do not give the evaluation of the real hazard of any pollutants and do not forecast the consequences of their influence on living organisms and environment [Klimenko 2006].

Bioecological diagnostics of the environment allows forming differentiated and integral picture of organisms and their ambient and thus has decisive importance [Semenkova, Sokolova 2003].

### 2. Problem formulation

Biological equilibrium in land and water ecosystems is supported by the dynamic connections between organisms and with abiotic factors of the surrounding environment. Anthropogenic influences can violate this equilibrium, which is reflected in species and numeral composition of biocenosis [Kipnis et al. 2002].

Based on the principle of unity of living organisms and environment, it is possible to assume that there are close correlative connections between the environment factors and reaction of living

organisms to them. Especially this is traced at plants, which are firmly fixed to the environment of their existence.

Building formal analogy based on the existence of correlation between the degree of external influence and reaction of organisms, it is possible to perceive these organisms as "sensitive elements" in the system of biological diagnostics and environment monitoring, whose condition changes directly under the influence of environment factors [Klimenko 2006].

The reaction of living organisms allows assessing anthropogenic influence on the environment with the indexes, which have biological basis. Factors, affecting the environment, are sometimes so much modified by the factors of living and not living nature and as a result the final influence is not always easily found out. Biological methods give clear integral picture, even for those pollutants, which are left out of measuring devices perception [Velichko, Zerkalov 2001].

### 3. Analysis of researches and publications

Some authors [Klimenko 2006; Velichko, Zerkalov 2001; Kipnis et al. 2002; Oleksiva 2005] give preference to the biological methods of testing over chemical and physical and chemical methods of the environment condition assessment. On the whole, advantages of these methods include [Semenkova, Sokolova 2003]: receiving quick answer about presence or absence of toxins; detecting the weakest anthropogenic changes in the environment quality, which are not even traced with measuring devices; discovering and preventing changes in the environment as soon as possible; evaluating pollution levels in case of large variety of situations in limited number of parameters or in points; solution of tasks, which couldn't be resolved with

other research methods; defining the consequences of one-time pollution, which could be skipped by other methods, as the results of chemical and physical-chemical analysis of the environment highly depend on the method of sampling; discovering and describing not only anthropogenic influence on the environment, which took place in the past, but also making prognosis for the future.

The analysis of different indexes shows that aviation and airtransport complex, generally, influences considerably the level of local and regional pollution of soils in the places of their location [Velichko, Zerkalov 2001].

Pollution of soils, which is caused by the activity of aviation processes, creates threats related to the worsening of surface and underground waters quality and vegetable associations.

Biological investigation of soil pollution levels at the territories adjoining to airports is extremely topical, as methods of assessing technogenic influence on soil condition is not covered enough in scientific literature.

The **purpose** of the study is the determination of soil quality with the integral index of toxicity in the area of aviation processes.

#### **4. The scheme of biological assessment of soils condition within the territory of “Kyiv” airport**

The study object has borders with agricultural lands to the southeast; residential buildings to the north-east and north; industrial area to the south-west and west; Kyiv-Zhytomyr highway and south-west railway to the west; the village of Zhulyani to the southeast and south.

Technical-environmental and structural parameters of airport production services include such objects: air transport; aviation-technical base, which consists of welding station, battery department, air equipment painting and washing department; special transport service, which includes lorry-loads, busses, passenger and special official cars, welding stations, painting, battery department; repair and constructional department, welding post; chief mechanics service, which includes welding and painting station, battery department; services of thermal engineering systems; base of the radio electro-engineering provision of airplanes flights; airfield service; fuel and lubricating materials service, which includes filling station, warehouse [Kipnis et al. 2002].

To analyze the state of soil ground cover within the limits of airport “Kyiv” the sampling of soils was conducted during 7 years based on specially developed scheme and their toxicity was studied. Such investigations were conducted for the study area for the first time.

Soil sampling included taking samples from the superficial layer of soil and from the depth of 20 cm every season at the distance 20 m, 100 m, 250 m, 500 m, 1000 m from the airport.

The soil samples were tested to define their pollution level and quality indexes in accordance with the requirements of GOST 17.4.2.01–81 and GOST 17.4.3.01–83 [1981; 1983].

Two study sections were chosen in the process of investigation, their area was 25 m<sup>2</sup> each. The first section was experimental in the zone affected by aviation processes, the second one is control on the clean territory not affected by technogenic processes.

Position of sampling points was marked on the map. The set points were used as landmarks to choose the location of sampling. All sampling points were fixed with benchmarks and marked on the map [Oleksiva 2005; Resolutions...1991].

Soil surface was cleaned from plants and litter before the samples were taken.

Samples were taken using the “envelope” method from the area 5x5 m. The incorporated sample was made by mixing material from five points of one probe ground. The mass of the incorporated sample was 1 kg [Resolutions...1991].

Samples of soils, which have undergone the influence of aviation processes, were processed to obtain water extractions, which were investigated by the methods of biotesting.

The determination of soil water extracts toxicity was conducted with the help of test organisms – *Daphnia magna* Straus, *Lactuca sativa* L. The test was conducted according to KND 211.1.4.054–97 [1997].

Samples were considered toxic, if 25% test organisms died during 48 hours, and extremely toxic, if the death rate of daphnia was 50% or oppressions of roots growth was more than 50%.

The toxicity testing was performed with young specimen of daphnia under age 24 hours.

Each experimental and control vessel contained ten daphnia under age 24 hours.

Results were taken in 1, 2, 24 and 48 hours. *Daphnia* were considered alive, if they moved freely in the layer of water or emerged from the bottom of vessel after shaking. Other *daphnia* were considered dead [Oleksiva 2005; Semenkova, Sokolova 2003; Velichko, Zerkalov 2001].

The method was based on the assessment of difference between the number of died *daphnia* in the experimental sample and in the control sample.

The criterion of toxicity in acute experiments was the survival indexes and death rate of experimental organisms (for *Daphnia magna*), in relation to the control samples, which stayed in their usual environment [Oleksiva 2005].

For every sample under investigation to provide calculations of  $LC_{50}$  at 95% confidence interval the number of water extraction concentrations was 5.

## 5. Results of soils toxicity determination

The results of soil water extracts biotesting with the use of experimental objects of *Daphnia magna* Straus are given at Fig. 1.

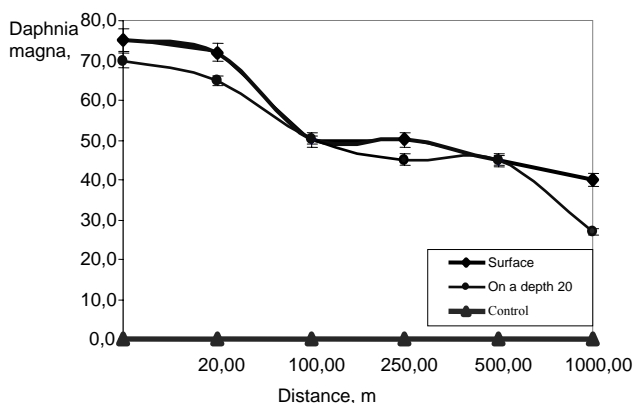


Fig. 1. The death rate of daphnia in water extracts of soil,  $M \pm m$ ;  $n = 9$

The death rate of *daphnia* is 75% in the samples of water extracts, derived from the samples of superficial layer of soil, near the runway, 72% – at the distance 20 m, 50% at the distance 250 and 500 m, 45% – at the distance 1000 m and 40% at the distance 1500 m in the tests of. As for the samples of soil taken from the depth of 20 cm, the death rate is 70% near the runway, 65% at the distance 20 m, 50% at the distance 250 m, 45% – at the distance 500 and 1000 m, and 27% at the distance 1500 m

The toxicity of soil water extracts was also studied with the help of tests on plants. The criteria of toxicity were the indexes of root growth oppression of sowing lettuce *Lactuca sativa* L in relation to control and percent of germination of

*Lactuca sativa* L seeds [GOST...1983; KND...1997; Resolutions...1991].

The biotest on lettuce the sowing analyzes growth of roots and estimates the early stages of development, growth and survival of plants. As a rule, growth of roots is inhibited at lower concentrations of toxicants, than seeds germination. Therefore it is more sensible indicator of biological influences.

Petri cup was prepared for each sample and control prepared. Filtration paper folded in two was laid in each of cup and moistened with water extracts. 25 seeds of lettuce (approximately identical in size, form and color) were placed in each cup. The Petri cups were closed and placed in dark, moist and warm place for 5 days.

The results of root growth inhibition fo *Lactuca sativa* in soil water extracts are resulted at Fig. 2.

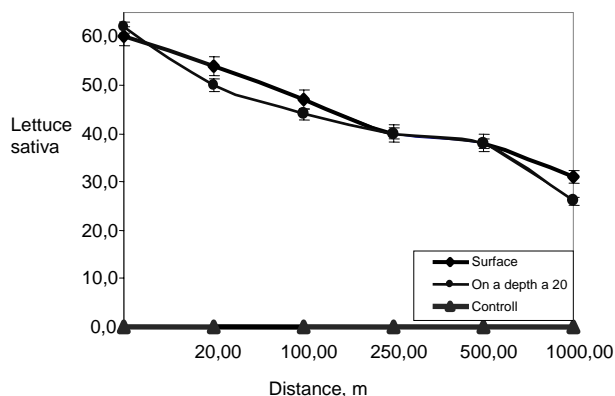


Fig. 2. Oppression of root growth at sowing lettuce,  $M \pm m$ ;  $n = 9$

The results of researches also indicate the oppression of root growth at lettuce sowing. Thus, the results for water extracts of samples taken from the superficial soil layer showed the oppression of root growth by 60% near the airport, 54% at the distance 20 m, 47% at the distance 250 m, 40% at the distance 500 m, 38% at the distance 1000 m, 31% at the distance 1500 m.

Water extracts, derived from soil samples, taken from the depth of 20 cm, also proved the oppression of root growth near the airport by 62%, by 50% at the distance 20 m, by 44% at the distance 250 m, by 40% at the distance 500 m, by 38% at the distance 1000 m, by 26% at the distance 1500 m.

Data received during the biotesting at various trophic levels prove that soil is toxic in all sampling points at the territories, adjoining to the enterprises of exploitation and maintenance of aviation equipment.

## 6. Conclusions

The results of the conducted researches prove that the soils in area of the airport “Kyiv” activity is considerably polluted due to aviation processes.

Analyses showed that the death rate of daphnia was 75% in the samples of water extracts, derived from the samples of superficial layer of soil, near the runway, 72% – at the distance 20 m, 50% at the distance 250 and 500 m, 45% – at the distance 1000 m and 40% at the distance 1500 m in the tests of. As for the samples of soil taken from the depth of 20 cm, the death rate is 70% near the runway, 65% at the distance 20 m, 50% at the distance 250 m, 45% – at the distance 500 and 1000 m, and 27% at the distance 1500 m

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It was also defined that soil toxicity also diminishes while the distance from the airport increases.

The received results prove the need to continue the study with the purpose to improve the environmental condition of the territory in the area of exploitation and maintenance of aviation equipment.

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Received 7 October 2013.

### С.М. Маджд. Біологічні методи оцінки екологічного стану ґрунту біля аеропортів

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Визначено якісні характеристики ґрунтового покриву за допомогою інтегрального показника токсичності в зоні впливу авіатранспортних процесів. Оцінку ґрунтового покриву здійснено на біотестах різних трофічних рівнів. Критерієм токсичності в гострих дослідах обрано показники виживання та смертності піддослідних організмів. Розглянуто результати біотестування водних витяжок ґрунту з використанням піддослідних тест-об'єктів *Daphnia magna* Straus. Показано, що смертність дафній становить 75% у пробах водних витяжок ґрунту біля злітно-посадкової смуги, 72% – на відстані 20 м, 50% – на відстані 250 і 500 м, 45% – на відстані 1000 м, 40% – на відстані 1500 м у пробах поверхневого ґрунту. Зазначено, що результати інгібування росту корінців *Lactuca sativa* у водних витяжках ґрунту вказують на пригнічення росту корінців салату посівного. У пробах водних витяжок поверхневого ґрунту встановлено пригнічення росту корінців поблизу аеропортів на 60%, на відстані 20 м – 54%, на відстані 250 м – 47%, на відстані 500 м – 40%, на відстані 1000 м – 38%, на відстані 1500 м – 31%. Описано, що в зоні діяльності аеропортів відбувається значне забруднення ґрунтового покриву, пов'язане з авіатранспортними процесами.

**Ключові слова:** авіатранспортні процеси; важкі метали; екологічна безпека аеропортів; забруднення; захист довкілля; нафтопродукти.

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Определены качественные характеристики грунтового покрова с помощью интегрального показателя токсичности в зоне влияния авиатранспортных процессов. Оценка грунтового покрова осуществлена на биотестах разных трофических уровней. В качестве критерия токсичности в острых опытах выбраны показатели выживания и смертности подопытных организмов. Рассмотрены результаты биотестирования водных вытяжек почвы с использованием подопытных тестовых объектов *Daphnia magna* Straus. Показано, что смертность дафний составляет 75% в пробах водных вытяжек почвы возле взлетно-посадочной полосы, 72% – на расстоянии 20 м, 50% – на расстоянии 250 и 500 м, 45% – на расстоянии 1000 м, 40% – на расстоянии 1500 м в пробах поверхностной почвы. Отмечено, что результаты ингибирования роста корешков *Lactuca sativa* в водных вытяжках почвы также указывают на угнетение роста корешков салата посевого. В пробах водных вытяжек поверхностной почвы установлено угнетение роста корешков вблизи аэропорта на 60%, на расстоянии 20 м – 54%, на расстоянии 250 м – 47%, на расстоянии 500 м – 40%, на расстоянии 1000 м – 38%, на расстоянии 1500 м – 31%. Описано, что в зоне деятельности аэропорта происходит значительное загрязнение грунтового покрова, связанное с авиатранспортными процессами.

**Ключевые слова:** авиатранспортные процессы; загрязнение; защита окружающей среды; нефтепродукты; тяжелые металлы; экологическая безопасность аэропорта.

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