ЕКОЛОГІЯ ФІТОСФЕРИ

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ADAPTIVE AND DESTRUCTIVE PROCESSES OF DENDROLOGICAL OBJECTS UNDER OIL CONTAMINATION CONDITIONS

The authors investigate the adaptive and destructive reactions of tree plants in response to oil pollution of the environment. The article states the decrease of vitality of the investigated plants according to a suite of metrics on cellular, organ, organism and population levels of the biosystem organization. Vegetative organs size reduction, asymmetry and necrotic damage of leaf blades, reduction of water saturation and increase of ash-content of dry material of tree leaves are revealed. The authors highlight the deterioration of the buffer system of the leaves protoplast as the cells that are the most sensitive to changes in the internal and external environment of plants organs.

Premature defoliation and colour change of tree crowns are the signs of organism aging which is the consequence of contamination, free radical processes. Based on the set of vitality parameters the tree species are placed in the row in accordance with the decrease of their stability: walnut → common sea buckthorn→ drooping birch → big-leaf linden → Norway maple→ little-leaved linden → ordinary horse chestnut.

The Norway maple, big-leaf linden, little-leaved linden, ordinary horse chestnut should be used in the phytoindicative studies of technologically transformed ecosystems. In the oil-polluted environment the destructive processes in the organisms of these species dominate over the adaptive ones. It is proved by the presence of pests and tree plants diseases caused by them. The protective mechanisms of the above mentioned plants, depleted in long-term stresses are unable to counter parasites, therefore the species cannot perform an environment-cultivative function effectively.

Walnut, drooping birch, common sea buckthorn are well adapted to stressful conditions of growth and are recommended for the amenity planting at the oil-contaminated areas in order to reclaim them. These tree species have such adaptive features as relative stability of the buffer system of assimilation organs cells, low level of necrosis, protection against metals and other pollutants.

Key words: adaptation, destructive processes, oil field, plants, environmental factors, environment.

Formulation of the problem. Adaptive and destructive indices of plants that arise in response to adverse growth conditions are markers of the level of technogenic pressure on specific ecosystems. These are two sides of a single phenomenon – stress – a combination of non-specific reactions of the organism to environmental factors that violate its homeostasis. Adaptation is aimed at restoring a stable equilibrium state of the biological system. Adaptive-protective reactions of plants involve optimization of metabolism by saving resources and energy [1, 3, 5].

There is a positive – eustress, and negative – distress – of the organism. The differences between these two types of stress consist in its duration and intensity of action. In the case of eustress, the resistance of the organism to the negative factor increases, as well as the functional reserve of the organism. Distress also leads to the depletion of the adaptive forces of the organism, the emergence of diseases and even death [6, 8, 10].

Oil pollution today is a global environmental problem, therefore the analysis of the physiological possibilities of plant systems adapting to this type of contamination and their environmental significance in these conditions is extremely important. As the primary recipients of anthropogenic factors influence tree plants are especially important in terms of their prospects as phytoindicators and phyto-remediants.

Analysis of research and publications. Visible damage to the organs of plants is a consequence of a number of biochemical reactions in the cells, the disruption of metabolic processes, the benefits of catabolic transformations over anabolic. At the molecular level of the biosystems organization all positive and negative influences on the organism are realized. External visible damage is only a consequence of the internal transformation and its reflection [11, 15, 19].

Under the influence of oil pollution of the environment, plants are mostly characterized by inhibition of vitality in general, but to varying degrees [8, 16]. Also there are known herbaceous plants that are well adapted to oil pollution and can even increase their vitality in such growth conditions [9]. Sustained and sensitive species that can be used as remediants and indicators of the ecological state of technogenically transformed environment were discovered by native [4, 13] and foreign authors [12, 20].

There are three types of plant resistance:

- physiological, which includes the state of the buffer system of cells, oxidation-reduction processes and enzymatic activity, water content in cells;
- morpho-anatomical, which represents barriers for the penetration of toxic compounds into the leaves and reduces their degree of damage;
- biological, which characterizes the ability of plants to restore damaged by pollution organs, which is common for plants with high ecological plasticity and rapid growth [18].

The leaves have high bioindicative promise, as they exhibit the obvious plasticity to the complex of environmental factors [2, 7, 14].

Selection of previously unsolved parts of the general problem.

Long-term green plantations have a special bioindicative value as they are exposed to the complicated environmental factors and perform a barrier function between pollutants and heterotrophs, including humans. Accumulating toxicants in their tissues, plants acquire a number of adaptive-protective changes in the case of wide environmental adaptation, or destructive processes that lead to the death of a biological object [6, 14]. Currently, the problem of adaptation to stress by plant organisms is relevant, since it allows to distinguish species resistant, sensitive to pollution or other environmental factors, to determine the limits of the survival of phytocoenoses, their distribution and role in ecosystems. Each species is characterized by individual biological and environmental capabilities, therefore, the study of the characteristic features of individual tree species under oil pollution has a practical and theoretical value for improving the state of the environment and avoiding unnecessary death of plant organisms.

Setting objectives. The purpose of our work was to investigate the visible signs of adaptation or destruction and the internal biological processes of tree plants that grow in conditions of the oil and gas deposit.

Presenting main material. We have studied the dechromatic, growth and cumulative features of woody species growing in the zone of influence of one of the oldest oil deposits in the world – Boryslav. Boryslav city is known for the high level of oil pollution of the environmental abiotic component – the surface layer of the air, soils, water resources. The selection of plant material was carried out from the lower part of the crown at the end of the assimilation system development [17]. 6-8 representatives of each species were analyzed that grew within a radius of 500 m from the deposit. As a conditionally ecologically clean area, the Demyaniv Laz forestwas chosen.

In the conditions of oil-contaminated territory, the growth of ash content in the dry weight of tree leaves was compared with the background area. *Aesculus hippocastanum* L. has the highest metal-accumulation ability, the content of ash in the leaves of which in the conditions of the deposit is three times higher relative to control. The species is most susceptible to environmental pollution, which is manifested by the appearance of necrosis on all investigated leaf blades. In addition, plants that are weakened by oil contamination become vulnerable to pests, in particular Cameraria ochidella Deschka and Dimic, Guignardia aesculli. *Aesculus hippocastanum* L. is characterized by the highest level of growth processes inhibition and violation of the buffer stability of the leaves tissues' protoplast.

Juglans regia L., on the contrary, is characterized by high resistance to oil pollution. We did not detect visible signs of damage to the assimilation organs, no pest damage was recorded. The buffer stability of the species is the highest compared to other tree species, indicating a significant resistance to contamination. The high absorption capacity of the mineral elements of *Juglans regia* L. proves its remediation properties. The ability of some herbaceous plants to detoxify aromatic hydrocarbons to harmless metabolic products makes it possible to ascertain the resistance and high adaptive potential of these plants to oil pollution.

Acer negundo L., under oil deposit conditions, is characterized by the leaves lesions with resinous spotty due to nitrogen deficiency in the soil. Black stains with a yellow border are available in more than half of the examined leaf blades. *Tilia cordata* Mill. and *Tilia platyphyllos* Scop. individuals suffer from parasites – lime mites, which are the cause of the emergence of germs. Lime aphids – one of the most common pests – affect 75% of the investigated leaves of both limes. Birch has a higher resistance to contaminants compared to other sensitive species, however, it is noted that there were leaves necrosis of the third degree and damage to the organs by a parasite complex – *Cacoecia xylosteana* L., *Cacoecia rosana* L., *Semidobia betulae* Winn., *Nectria cinnabarina* Fr.

Under the influence of the Boryslav petroleum deposit, there is a chronic damage to the assimilation apparatus of tree plants. This is a consequence of the constant penetration of the leaves and other organs of gaseous compounds or their solutions through the root system. We detected the appearance of necrosis, reducing the size of leaves, increasing the level of crown dehromation. It is inextricably linked with a decrease in water content and an increase in the number of ash elements. Accumulation of ash in plant tissues leads to inhibition of functional activity, the structure of photosynthetic organs as a result of blocking the activity of enzymes. As you know, heavy metals, which make up the main part of ash in a plant, are life-threatening, since displacing cations from active centers of enzymes, inactivating them. In turn, sulfur and nitrogen, which are part of the oil, interacting with air, subsequently deposite on the surface of plants, causing burns, the appearance of necrosis, weakening the protective properties of plants. In this case, the plants become very susceptible to pests and diseases [19].

We detected the appearance of premature aging of plants under the influence of petroleum products, indicating a violation of homeostasis of phytocoenoses and ecosystems in general. Oil components destructively act on living systems, poisoning the body with compounds that have mutagenic characteristics. Plants are a raw material for human food and nutritional needs, as well as a source of food for animals. Thus, the movement of toxic components of oil through the trophic chains of the food pyramid occurs and the vitality of organisms on its links is carried out.

According to the complex of vitality indicators, the stability of woody species in the conditions of the oil deposit decreases in the following row of plants: *Juglans regia* L. → *Hippophaer hamnoides* L. → *Betula pendula* Roth. → *Tilia platyphyllos* Scop. → *Acer negundo* L. → *Tilia cordata* Mill. → *Aesculus hippocastanum* L.

Conclusions. A common feature for all investigated tree plants that grow under the influence of the Boryslav oil deposit is the predominance of destructive processes in the organism over adaptive ones. There is a tendency to increase catabolic processes over anabolic, as evidenced by a decrease in biomass, inhibition of growth and the development of phyto objects under the influence of environmental contamination by petroleum products. This is the result of internal molecular changes consisting in the inactivation of vital enzyme systems, blocking the biosynthesis of proteins, and inhibition of cell division. Changing the color of the leaf blades of trees, the appearance of necrosis in most species is a visual indication of unfavorable environmental conditions. The increase in ash content and the reduction of water resources in the assimilation organs of trees indicates the depletion of the tread properties of the biological system, which creates conditions for the spread of pests and diseases. Physiological changes in the cells of the investigated plants confirm all visible signs of depression of organisms under the influence of oil pollution. The weakening of buffer stability is directly related to the premature aging of phyto objects, which is manifested in the defoliation of the crown, the appearance of persistence and dying of assimilation organs. Types react differently to oil pollution, so we divided them into three groups. Sustainable include *Juglans regia* L., *Hippophaer hamnoides* L., *Betula pendula* Roth. and sensitive ones – *Tilia cordata* Mill., *Aesculus hippocastanum* L. The middle position is occupied by *Tilia platyphyllos* Scop. And *Acer negundo* L.

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ОСОБЛИВОСТІ АДАПТИВНИХ І ДЕСТРУКТИВНИХ ПРОЦЕСІВ ДЕНДРООБ'ЄКТІВ В УМОВАХ ВПЛИВУ НАФТОВОГО РОДОВИЩА

Досліджено адаптивні та деструктивні реакції деревних рослин у відповідь на нафтове забруднення довкілля. Встановлено зниження життєвості досліджених рослин за комплексом показників клітинного, органного, організмового та популяційного рівнів біосистемної організації. Виявлено зменшення розмірів вегетативних органів, появу асиметричності та некротичних ушкоджень листкових пластинок, зниження вмісту води та зростання зольності сухого матеріалу листків дерев. Встановлено погіршення стану буферної системи протопласту листків як найчутливішого до змін внутрішнього і зовнішнього середовища органів рослин.

Передчасна дефоліація та дехромація крони дерев є ознакою старіння організму, що є наслідком, спричинених забрудненням, вільнорадикальних процесів. За комплексом параметрів життєвості деревні види розміщені в наступному ряді відповідно до зниження їх стійкості: горіх волоський → обліпиха крушиноподібна → береза повисла → липа широколиста → клен гостролистий → липа серцелиста → гіркокаштан звичайний.

Клен гостролистий, липу серцелисту, липу широколисту та гіркокаштан звичайний доцільно використовувати в фітоіндикаційних дослідженнях техногенно-трансформованих екосистем. В умовах нафтового забруднення у цих видів переважають деструктивні процеси над адаптивними, про що свідчить наявність шкідників та спричинених ними захворювань деревних рослин. Захисні механізми у виснажених тривалим стресом вище зазначених рослин нездатні протидіяти паразитичним організмам, тому види не можуть ефективно виконувати середовищетвірну функцію.

Горіх волоський, береза повисла, обліпиха крушиноподібна добре пристосовані до стресових умов зростання та рекомендовані до впровадження у озеленення нафтозабруднених територій з метою рекультивації останніх. Адаптивними особливостями цих деревних видів є відносна стабільність буферної системи клітин асиміляційних органів, низький рівень ураження некрозами, наявність протекторних особливостей від металів та інших забруднювачів.

Ключові слова: адаптація, деструктивні процеси, нафтове родовище, рослини, екологічні фактори, довкілля.

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