Developing technology of remediation of oil-contaminated soils

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Abstract* – *The results of developing technologies for cleaning of soils from oil pollution on the example of Boryslav are shown. The prospects of tree species for the remediation of oil-contaminated soils are studied. The best results of cleaning oil contaminated soils with the application of Hippophae rhamnoides L. plants were obtained. It is a promising measure for restoring the oil-contaminated soils, attractive both from environmental and economical point of view.

Key words – oil-contaminated soils, technologies of remediation, a phytoremediation, *Hippophae rhamnoides* L., a phytotoxicity, secondary fuel.

I. Introduction

Extremely dangerous source of effects on the soil ecosystem is oil-extracting industry. It contaminates large areas by oil. Soils have the ability to accumulate pollution, and in turn, become a source of secondary pollution of air, surface and groundwater. Therefore, the problem of cleaning soil from oil pollution is important task at present.

There are various ways to restore soils but not all of them are definitely effective and economically profitable. It was shown that one of the most effective ways to rehabilitate contaminated areas are technologies of remediation. Plants are known to degrade and stimulate the degradation of contaminants in soil [1-7]. Phytoremediation, the use of vegetation for the in situ treatment of contaminated soil is an emerging technology that promises effective and inexpensive cleanup of certain hazardous pollutions. The use of plants to reduce contaminant levels in soil is a cost-effective method of reducing the risk to human and ecosystem health posed by contaminated soil sites. This review concentrates on plant–bacteria interactions that increase the degradation of hazardous organic compounds in soil. Plants can form specific associations in which the plant provides the bacteria with a specific carbon source that induces the bacteria to reduce the phytotoxicity of the contaminated soil. Alternatively, plants can form nonspecific associations in which normal plant processes stimulate the microbial community, which in the course of normal metabolic activity degrades contaminants in soil. Plants can provide carbon substrates and nutrients, as well as increase contaminant solubility. These biochemical mechanisms increase the degradative activity of bacteria associated with plant roots. In return, bacteria can augment the degradative capacity of plants or reduce the phytotoxicity of the contaminated soil.

II. Results and discussion

Phytoremediation is the most promising environmentally friendly way of remediation of oil-contaminated soils in terms of simplicity and efficiency, characterized by long-term exposure and stable improvement of the environmental situation.

The technologies of soil cleaning from oil pollution are being developed and tested on the Boryslav oil deposit. Targeted search of tree species (*Salix babylonica* L., *Betula pendula* L., *Hippophae rhamnoides* L., *Prunus cerasifera* L.) was conducted for remediation of oil-contaminated soils and a secondary fuel source.

The best results of cleaning oil contaminated soils were obtained with the application of *Hippophae rhamnoides* L. plants. *Hippophae rhamnoides* L. roots can tolerate long periods of flooding and waterlogging. The thick leaf of plants of these species and thick cuticle of leaf are protective devices that provide economical consumption of water in the condition of high insolation and temperature. The elevated part of these plants can tolerate of inside the plant water deficit, and actively adjust the rapid changes in osmotic pressure of the cell sap [8]. This combination of resistance to flooding and drought conditions make optimal of these plans to use for the phytoremediation of oil contaminated soil. We have shown that the *Hippophae rhamnoides* L. plants successfully adapt to the extreme conditions of oil contaminated soils, improve its physical and chemical properties, enrich it with nitrogen compounds, and reduce the amount of oil in the ground. Cleaning soil from oil pollution reaches 92.7% (Fig. 1).

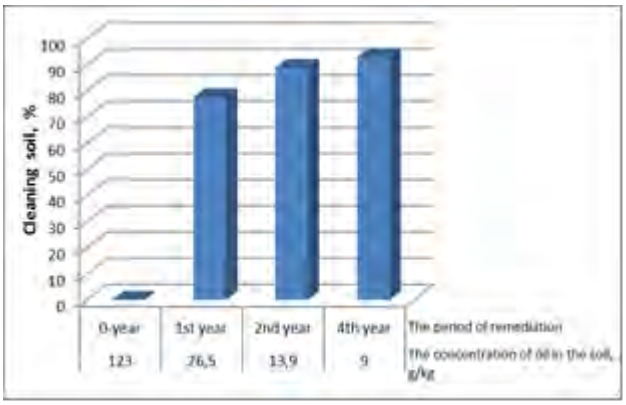

Fig. 1. Effect of *Hippophae rhamnoides* L. plants on degradation of oil in the soil during 1-4 years of growth. The initial contamination of soil by oil 123 g/kg

The plants of these species decrease of toxicity of contaminated soil and improve its microbiological properties too. Relative germination of seed of *Linum usitatissimum* L. plants increases from 0 to 108,6% during four years phytoremediation. Relative length of root and relative height of sprout of test-organism increases to 163,4% and 142,4%, respectively (Fig. 2).

A particular advantage of *Hippophae rhamnoides* L. plants is the capability of growing them in tree nurseries. The land reclamation area increased in 3 times during four years of phytoremediation. It is shown on the figure 3 and figure 4.

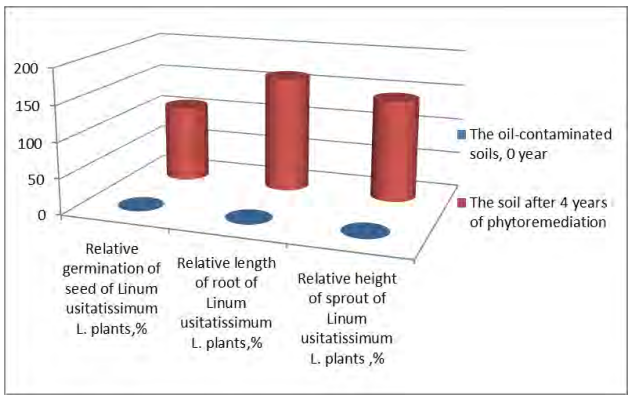

Fig. 2. The phytotoxicity of oil-contaminated soils before and after phytoremediation by *Hippophae rhamnoides* L. plants. Test organisms – *Linum usitatissimum* L.plants

Fig. 3. The experimental reclamation area, first year of phytoremediation

Fig. 4. The experimental reclamation area after four years of phytoremediation

This makes the method economically attractive. Moreover, wood of *Hippophae rhamnoides* L. plants has a high specific heat of combustion – 4,8 kcal/kg, which is significantly higher than in most species of wood. 1 ton of wood of *Hippophae rhamnoides* L. plants corresponds with 0.68 tons of coal. It allows to use it as an independent fuel or to produce liquid fuel.

Conclusion

Phytoremediation is an emerging and the most promising technology of remediation oil-contaminated soils. *Hippophae rhamnoides* L. plants are a promising agent for remediation of oil-contaminated soils, attractive from both environmental and economic point of view.

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