

# Fluorescent monitoring of phytomelirants of man-made landscapes of the Yavoriv mining industry district

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**Abstract** – *Actuality of fluorescence monitoring of regionalization and degradation transformations of ecosystems of Yavoriv mining industry is considered. Identification of forest conditions and express diagnostics of photosynthetic apparatus of plants was performed. The methodological principles of using integral information on the basis of morphophysiological and fluorescence characteristics of plants for phytomelioration of technogenic landscapes are given.*

Keywords – monitoring, fluorescence, photosynthesis, technogenic landscape, mining industrial area, phytomelioration.

## Introduction

**Problem solving in general and its connection with important scientific and practical tasks.** Modern concepts of management of man-made ecosystems of the Yavoriv mining industry district (GPR) are based on the widespread use of comprehensive monitoring data. The use of modern information-analytical methods and technologies in the selection, accumulation and analysis of the parameters of the functioning of the components of biogeocoenoses, is relevant for: assessment of the dynamics of spatial and temporal changes in technogenic landscapes; determination of the specificity of the manifestation of degradation and renaturalization processes in morphophysiological indices of plants and spatial-species structure of plant groups, analysis of the effectiveness of phytomelioration; formation of scientific principles of technologies of protection and restoration of natural technogenic ecosystems.

**An analysis of recent research and publications, which initiated the solution of this problem, which is based on the author.** The analysis of research on the environmental problems of mining of sulfur deposits indicates the existence of a fundamental basis of the phenomenology of environmental safety of mining regions of Ukraine [1]. The authors [2-4] summarize numerous, in-depth, and detailed, but fragmentary and disparate results of geocological researches of the mining complexes of Precarpathians. Landscaping, geological, geographic studies of the influence of mining industry on the environment are devoted to the work Grodzinsky MD, Ivanova Ye.A., Kovalchuk I.P. etc. Problems of environmental safety at the stage of liquidation of sulfur mines are devoted to works by Y.M. Semchuk, Y.I. Kryzhanivsky Korina S.C. etc. The questions of engineering protection of sulfur deposits of the Carpathian region are devoted to the work of Rudko GI, Gaydin AM, Zozulii I.I., Dyakiv VO. etc. Information, software and mathematical support for evaluating the karstic and shift processes induced by mining workings are covered in the works of Adamenko Ya.O., Chepurnogo IV, Kuzmenka E.D., Ivanik A.M. etc.

The considered works indicate the need for an integrated approach to environmental protection in mining complexes, the use of elements of unification and adaptation of technologies for the protection of the natural and man-made environment, to real objects. The logical continuation in the scientific works of technological schemes and technical decisions of monitoring, stabilization of technogenesis and ensuring environmental safety is the development of conceptual foundations of phytomelioration of man-made landscapes.

V. **Selection of previously unsettled parts of the general problem, to which this article is devoted.** The analysis of the natural and climatic conditions of Yavorivsky GPR proves the expediency and necessity of forest-meliorative transformation of man-made, degraded and unproductive lands. Taking into account that forest cenoses use up to 90% of solar energy (agrocenoses - only 40%), and also taking into account that the harmonious development of a society with nature requires a ratio of forest vegetation to agro-landscapes within 50% [5], on lands that have undergone man-made impacts, it is advisable to create forest cultures of phytocoenoses, which would fulfill various vital protective functions. Therefore, monitoring of the processes of afforestation of man-made landscapes of the Yavorivsky GPA will contribute to improving the quality of the environment, increasing forestry in the mining regions, and attracting land with disturbed soil to the economic flow of land.

**Formulation of the purpose of gender (statement of task).** The purpose of the research is to express the diagnosis of morphophysiological indices of plants, to obtain information on the signs and properties of the objects of natural and technogenic biogeocoenoses, necessary for a qualitative interpretation of the biodegradability of phytomelirants of technogenic landscapes.

**Object of research.** As the object of comparative research, the main forests of the crop species of forests - oak are commonly used to determine and compare the vitality index in different types of forest vegetation. The test material is selected from underground sulfur (PVS), control samples - from adjacent undisturbed terrain.

**Subject of study.** The subject of research is the processes of stress adaptation of the plant, general functional changes in the assimilation apparatus of oak ordinary in different environmental conditions determined by the complex of fluorescence parameters.

**Research methods.** The research methodology includes field surveys of technogenic and natural landscapes, sampling, laboratory measurements of plant morphophysiological parameters, and the formation of a database of fluorescence monitoring results. The activity of photosynthetic apparatus isolated from leaves of plants was investigated by the method of photoinduced fluorescence of chlorophyll (FH) [6]. Before the measurements, the sheets adapt to the conditions under which the FX measurements will be made. The sheet must be adapted to the darkness for 3 minutes before installing into the sample compartment. Inductive curves of FS are measured by a dynamic fluorimeter. The spectral selection of the excitatory ( $\lambda = 450-550$  nm) and the registered radiation ( $\lambda = 680-760$  nm) is carried out with the help of glass filters. Registration time is 3 minutes. The time dependence of FH is recorded by the recorder. The ratio of the maximum and background amplitude of inductive transitions is recorded by an oscilloscope. The mathematical models of FK kinetics graphs are executed in Excel, using the "Graph2Digit" program. To test the results of the research, the Styudents criterion was used.

Presentation of the main research material with full justification of the received scientific results. The phytomelioration of the Yavoriv GPR territory is necessary to stop the man-caused degradation of land and the return of devastated territories to recreational and economic use. Optimization of the ecological situation provides a wide range of ecological and economic measures based on the data of testing the morphophysiological parameters of floristic elements at the initial stage of the recultivation succession of the formation of vegetation on the technogenic soil substrates of Yavorivsky GPR.

The results of investigations of the kinetics of induction transitions of FX showed a significant difference in the fluorescence intensity of the investigated objects. Figure 1 shows the kinetic changes of FH oak in the natural and man-made landscapes of Yavorivsky GPR in two consecutive sampling samples. The insert of Fig. 1 shows the value of the vitality index (Rfd),

which reflects the deactivation of the photosynthetic apparatus due to the deterioration of the conditions of location.

The largest induction maximum is observed in the control plants of the forest from the adjacent area. The smallest - from the territory underground smelting sulfur, characterized by the largest man-made degradation of land. Reducing the maximum induction of FH indicates changes in the activity of the donor part of the photosystem 2. The obtained data indicate the inhibition of the transport of electrons along the transport chain from absorbing light quanta of pigments and their centers to acceptors. The deterioration of the conditions of location, in addition to the change in the amplitude of FH, is accompanied by characteristic changes in the kinetics of photoinduced transitions FH.

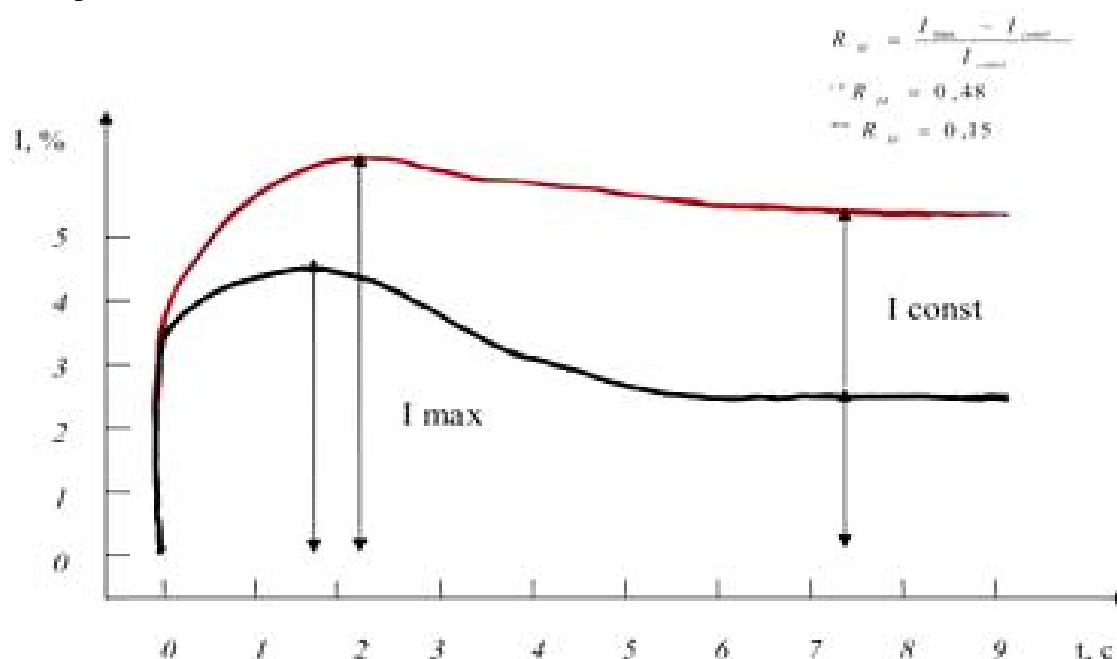


Figure 1. The kinetics of the photoinduced fluorescence of oak in the natural and technogenic landscapes of the Yavoriv GPR. On the insert - the value of the index of vitality.

In the fluorescence induction of photosynthetic objects, two components are distinguished: fluorescence variable, which carries information about the functioning of the photosynthetic apparatus (parameter) and background fluorescence, which reflects the state of "antenna" chlorophyll (parameter). By the nature of the decline of the quantum yield of FS, one can estimate the functioning of the photosynthetic apparatus by determining the vitality index. This parameter of photosynthetic activity is determined by the ratio:

$$R_{fd} = \frac{F_d}{I_{const}} \quad (1)$$

where  $F_d = I_{max} - I_{const}$  - reduction of fluorescence of chlorophyll from the maximum value to the stationary level, due to the activation of the carbonase photosynthesis enzymes.

Based on the comparative measurements of the kinetics of FH in vivo, the index of vitality of plants is determined ( $R_{fd}$ ), the meaning of which is given in Table 2. Maximum value  $R_{fd}$  testifies to optimal conditions of location. With the increase in the intensity of the environmental factor, a decrease in value is recorded  $R_{fd}$ , which reflects a decrease in the potential activity of the photosynthetic apparatus of plants.

The correlation of the measurement of the content of pigments [7] and fluorescence testing shows that the adaptation of the pigment apparatus to the corresponding environmental conditions is an integral part of the species survival strategy in a particular environment.

**Conclusions from this study and prospects.** The work confirms the efficiency of the diagnostics by the method of photoinduced fluorescence of chlorophyll of the vitality of plants, since the potential activity of the photosynthetic apparatus is tested without disturbing the integrity of the object. Fixed values of the vitality index of plants indicate the sufficiency of degraded conditions for the existence and development of pioneer vegetation.

Due to its high efficiency, fluorescence monitoring of forest technology of technogenic landscapes occupies a prominent place in the complex of measures on ecological safety, localization of degradation processes, improvement of the structure of the land fund and sustainable development of mining regions.

The process of phytomelioration of the Yavoriv GPR takes place extensively (self-growing) and intensively (artificial breeding), ensuring the cessation of man-made degradation of land and the return of territories to recreational and economic use.

The obtained results and the literature data on forest crops growing on broken soils indicate the success of reclamation of modern dumps of mining quarries with the help of mixed crops with the use of *Quercus robur* oak and an admixture of alder (*Alnus glutinosa*), common aspen (*Ropulus tremula*), pine usual (*Rennus sylvestris*). Despite the low productivity, these plantations are characterized by sufficient biological resistance. The implementation of phytomelioration measures should ensure the consistent formation of stable plant communities. The success of phytomelioration depends on the correct selection of a complex of agro-technical and forest-cultural measures in accordance with the ecological specificity of man-made landscapes.

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