TAXONOMIC AND FUNCTIONAL STRUCTURE OF THE MICROBIAL COMMUNITIES OF DARK GREY SOIL

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We analyzed the functional and taxonomic structure of microbial community of dark grey soil, depending on the effects of the weather and fertilizer systems. It was shown that fallow soil is characterized by integrated and more stable microbial community compared with agroecosystems soil. However, under the effect of such abiotic factors as increased average monthly temperatures and moisture deficiency, some imbalance of trophic interactions in microbiocenosis is observed.

Agroecosystems are characterized by less stable functional and taxonomic structure of the soil, which is defined by the hydrothermal conditions of the growing season and types of fertilizers applied. This is supported by a smaller number of correlations and a simplified structure of correlation pleiades of the soil of agroecosystems during unfavourable periods of vegetation periods, especially in the soil without fertilizers and using only mineral fertilizers. The use of organic and mineral fertilizer system brings the state of the soil microbiocenosis of agroecosystems soil to that of fallow soil.

Keywords: *microbial communities, dark grey bleached soil, functional and taxonomic structure, weather conditions, fertilizer system.*

Studies of the influence of climate on soil formation processes and soil properties were conducted from the time of work of V. Dokuchaiev, however, many not fully clarified aspects still exist. This is issue is of particular relevance in the context of changes on climate, since soil and its organic part contains significant amount of carbon. While soil itself and soil cover, according to V. Rozhkov [1], are witness and indicators of the global climate change.

Climate change directly affect energy level and hydrothermal regimen of soil, and indirectly through effects on other soil formation factors – plants, vital activity of organisms, etc. [2]. Given the crucial value of microbiological component of soil in biogeochemical circulation of carbon, nitrogen and other elements and global flows of greenhouse gases (CO₂, CH₄, and N₂O), considerable scientific interest is paid to the reaction of microbiota, its biochemical activity and soil fertility on changes in the climatic parameters [3-5]. Microbiological processes depend on the environmental

factors such as temperature, humidity, CO₂ concentration in atmosphere, availability of nutrients, all of which are likely to be affected by climate change [6].

In this regard, the aim was to study functional and taxonomic structure of microbial communities of dark gray soil under different hydrothermal conditions and application of fertilizers.

Materials and methods. To determine functional and taxonomic structure of microbiocenosis of dark gray soil, experimental data of studies obtained at the Microorganisms Ecology Laboratory of the Institute of Agroecology and Environmental Management of the NAAS were used [7; 8]. Samples of soil were selected in the stationary field experiment at the Institute of Agriculture of West Woodlands of the NAAS (Rivne State Agricultural Experimental Station) with the following options: 1 – without fertilizer (control), 2 – mineral fertilization system (NPK), 3 – organic mineral fertilization system (manure + NPK) and at the

surrounding territory – natural ecosystem (fallow).

Sampling of soil for microbiological tests was conducted from topsoil 0-20 cm between rows of sugar beets in July, when the system reaches steady state [9]. Soil type – dark gray bleached; $pH_{sal.}$ – 5.8; humus content – 1.8 %; easily hydrolysed nitrogen compounds – 117 mg/kg of soil; mobile phosphorus – 235 mg/kg of soil; exchangeable potassium – 87.5 mg/kg of soil.

The number of microorganisms of the main functional and taxonomic groups was measured by common method for soil microbiology seeding of successive dilutions of water-soil suspension on standard digest media [10; 11] eutrophic plants (EU) that use nitrogen of organic compounds – on meat-and-peptone agar; microorganisms using nitrogen of mineral compounds (EM) – on starch-ammonia agar (SAA); pedotrophs (PT) – on soil agar (SAG); nitrogen fixing bacteria (NFB) – on Vynohradskyi nitrogen-free medium; oligotrophic microorganisms (OT) – on starvation agar (SA); cellulolytic microorganisms (CL) – on Vynohradskyi medium with cellulose modified by Pushkinska; nitrifying (NF) – on starvation agar with ammonium magnesium salt; total bacterial count – on peptone-glucose agar with soil extract; micromycetes – on Czapek medium at pH 5.0; streptomycetes – on starch ammonium agar.

To evaluate the functional structure of soil microbiocenosis depending on the type of soil fertilizers and weather conditions, the modified method of correlation pleiades [12; 13] and the corresponding software for their plotting developed at Harvard University was used [14] Mathematical processing and statistical analysis of the results obtained during studies was performed under the recommendations of manuals on statistical analysis of experimental results and software “Statistica”, Microsoft Office Excel.

To characterize the hydrothermal regime of vegetation period, data of Rivne regional meteorological station were used, at

the same times years for which contrast in summer air temperature differential and the amount of rainfall during the period of measurement of quantitative characteristics of soil microbial communities were selected. In particular, analysis of meteorological data for the Region of Rivne showed excess in air temperature in July 2004 by 1.4 °C from average long-standing level (ALL) (Fig. 1). In addition, during the next years of study, annual temperature increase by 0.5 °C took place. As for humidity, 2004 was the most water-deprived, when moisture deficiency was 28 mm. In 2005, when slight water-deprivation was observed, rain fell on 14 mm lesser during ALL. In 2006, there was excessively wet weather, the excess of rain from ALL this year amounted to 45 mm.

Thus, July 2004 was extremely moisture-depleted, 2006 – hot with excessive moisture, 2005 – arid, but approaching the ALL.

Thus, for fallow soil integrated and more sustainable microbial community is typical compared with agro-ecosystem soil. However, under the action of such abiotic factors as increased monthly average temperatures and lack of moisture, some imbalance is observed in the trophic relations of microbiocenosis.

Less stable functional and taxonomic structure of soil is typical for agro-ecosystem, which is defined both by hydrothermal conditions of the vegetation period and the types of fertilizers applied. This is confirmed by lesser number of correlation interactions and simplified structure of correlation pleiades of agro-ecosystem soil under unfavourable periods of vegetation.

Structure of soil microbiocenosis without application of fertilizers and under use of mineral fertilizers is the most vulnerable to weather factors. Due to the ability of many microorganisms to move from energy-intensive processes of ensuring their nutritional needs to assimilation of readily available forms of biogenic elements from fertilizers, application of mineral fertilizers introduction causes rupture of

many trophic relationships in microbial community. The structure of correlation pleiades suggests that the application of organic mineral fertilizers contributes to the increased stability of the microbial communities of soil and approaches it to the parameters of soil of natural ecosystem.

Fig. 1. Monthly average values of air temperature (a) and amount of rain (b) in July 2004-2006, Region of Rivne, Village of Shubkiv.

Note: ALL – average long-standing level.