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Changes in the biological diversity and concentration of total DNA under the influence of mineral fertilizers in agrochernozemic soils

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Chernozems represent the most valuable soil resource for Russian agriculture. Their sustainable use in intensive farming systems with preservation of the biological diversity and biological activity of these soils is of crucial importance for the agri-environmental security of Russia.
We studied the influence of different rates of mineral fertilizers on the biological activity of chernozems on experimental fields of the Dokuchaev Research Institute of Agriculture in Kamennaya Steppe (Voronezh oblast).
Soil samples were taken at the end of April 2013 from the plow horizon on trials with different rates of fertilization: NPK-0, NPK-60, and NPK-120 (kg/ha); a long-term fallow plot was used as an absolute control.
The biological activity was analyzed by routine inoculation methods and by the molecular biology techniques based on DNA isolation from the soil samples. Quantitative parameters of the isolated and purified DNA were determined by measuring the fluorescence of the DNA preparations with added intercalating dyes; GelDoc XR system and Image Lab and TotalLab Quant. software were used.
Microbiological studies showed the high biological activity of the chernozems soil in all the trials. No significant differences were found between the trials for the microbiological processes of the carbon cycle.
There was a weakly expressed tendency for an increase in the activity of actinomycetes from the soil with zero fertilization (5.11 log10CFU/g) to the soil with maximum (NPK-120) fertilization (5.69 log10CFU/g) and the fallow soil (5.73 log10CFU/g); the number of cultivated micromycetes decreased from the soil with zero fertilization (4.76 log10CFU/g) to the soil with maximum fertilization (4.14 log10CFU/g) and to the fallow soil (4.1 log10CFU/g).
A less equilibrium state is typical of the microorganisms participating in the nitrogen cycle. The number of cultivated aerobic and anaerobic nitrogen-fixing bacteria somewhat increased in the fertilized trials (NPK-60, NPK-120). The most active development of denitrifiers was in the fallow soil.
It is known that cultivated forms comprise only about 1 to 10% of the total number of soil microorganisms. Quantitative analysis by the methods of molecular biology makes it possible to consider the full range of microorganisms. The concentration of extracted DNA can serve as an indicator of the total "biogenity" of the soil, as we isolated the genetic material of all organisms living in the soil.
The highest concentration of DNA found in the samples from the fallow soil. Much lower values were found in the soils treated with mineral fertilizers: 38.9% in trial NPK-60 and 53.3% in trials NPK-120 and NPK-0.
Thus, to sustain biota in cultivated chernozems and to improve the ecological state of the fields, the rates of mineral fertilizers have to be properly controlled. Moderate rates can be recommended. Features of the soil microbiome can serve as universal and sensitive indicators of the state of the soils under different farming systems. The quantitative analysis of isolated total DNA is an efficient tool to control the ecological state of the soils, especially those involved in agriculture.