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Changes in microbial activity of soils during the natural restoration of abandoned lands in central Russia

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Most changes in land use affect significantly the amount of soil organic carbon (SOC) and alter the nutrition status of soil microbial community. The arable lands withdrawal induced usually the carbon sequestration in soil, the significant shifts in quality of soil organic matter and structure of microbial community. This study was aimed to determine the microbial activity of the abandoned lands in Central Russia due to the process of natural self-restoration.

For the study, two representative chronosequences were selected in Central Russia: (1) deciduous forest area, DFA (Moscow region, 54o49N'; 37o34'E; Haplic Luvisols) and (2) forest steppe area, FSA (Belgorod region 50o36'N, 36o01'E Luvic Phaeozems). Each chronosequence included current arable, abandoned lands of different age, and forest plots. The total soil organic carbon (Corg, automatic CHNS analyzer), carbon immobilized in microbial biomass (Cmic, SIR method), and respiratory activity (RA) were determined in the topsoil (0-5, 5-10, 10-20 and 20-30 cm layers) for each plots. Relationships between Corg, Cmic, and RA were determined by liner regression method.

Our results showed that the conversion of croplands to the permanent forest induced the progressive accumulation Corg, Cmic and acceleration of RA in the top 10-cm layer for both chronosequences. Carbon stock increased from 24.1 Mg C ha-1 in arable to 45.3 Mg C ha-1 in forest soil (Luvic Phaeozems, Belgorod region). In Haplic Luvisols (Moscow region), SOC build up was 2 time less: from 13.5 Mg C ha-1 in arable to 27.9 Mg C ha-1 in secondary forest. During post-agrogenic evolution, Cmic also increased significantly: from 0.34 to 1.43 g C kg-1 soil in Belgorod region and from 0.34 to 0.64 g C kg-1 soil in Moscow region. RA values varied widely in soils studied: from 0.54-0.63 mg C kg-1h-1 in arable plots to 2.02-3.4 mg C kg-1h-1 in forest ones. The close correlations between Cmic, RA and Corg in the top 0-5cm layer ($R2 = 0.81$-0.90; $P<0.01$-0.05) were observed for both soils. Concluding, the conversion of former arable soils to native vegetation led to significant increase in respiratory and enzymatic activity, total and microbial carbon in the former plough layer.

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