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Multiscale view on structure of Haplic Chernozem under shelterbelt and arable areas

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In 1950-60 years on the territory of the USSR was laid a network of shelterbelts for protection from wind and water erosion, precipitation management and increasing yields. Afforestation was carried out in continuously tilled soils. Goal of this research is to study microstructure and identify transformation aspects of the humus horizon of Haplic Chernozems (Kursk region, Russia) depending on the type of land use.
Transect through 3 types of agricultural lands - arable land, forest belt and bare fallow was studied. The aggregate composition (AC) was determined by automatic dry sieving method. Aggregate water stability was determined by wet sieving method. Particle size distribution (PSD) and microaggregate composition (MC) were analyzed using laser diffractometry. Tomographic studies were conducted in selected monoliths of soils and individual fractions of aggregates using x-ray tomography.
PSD of investigated objects is bimodal with maximum in the 3.3 μm and 26 μm areas (silty clay loam, ISSS). MC of all objects is homogeneous and characterized by the dominance of particles with 50 μm size. However, it should be noted in the layer of 0-10 cm of soil under afforestation the emergence of resistant microaggregates the size of 100-350 μm.
AC showed favorable impact of afforestation on the structural properties of soils. In the shelterbelt soils fractions of 1-2 and 3-5 mm dominate, high aggregate water stability is high up to 40 cm. Plouging leads to consolidation of the dominant aggregate fraction and overall water stability reduction. In the plough layer of bare fallow soil content of >10 mm aggregates reaches 40-50%. In plough pan at a depth of 30 cm aggregates are characterized by high water stability.
Analysis of shelterbelt soil tomograms showed a wide range of structures: areas with crumb-granular and massive structure, and areas of intense biogenic transformation. The arable land soils have a more compact structure: crumby with highly branched pore space. Moreover, at a depth of 20-25 cm there is a tendency towards the excessive soil consolidation and the appearance of large hollow spaces covered with fine-grained material. The bare fallow soil at a depth of 5-10 cm soil can be divided into two contrasting states: consolidated and loose between compressed areas. There are clear signs of soil structural degradation such as appearance of a horizontal crack-like pores and areas with overcompact structure. Extensive soil dispersion was registered at depth of 20-25 cm. The soil of arable land behaves in a similar way, but through the impact of agricultural plants consolidation is not observed.
Analysis of microstructure of humus horizon of Haplic Chernozem showed distinctive differences in soil formation between all objects. Intensive impact leads to homogenization, degradation, consolidation, and destruction on all levels of soil organization. At the same time in the soil under afforestation there are several natural processes: recovery of structure, increasing of aggregate water stability, formation of sustainable microaggregates and growing of soil biota activity.