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Intra-soil milling for long-term efficient land use prospects

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Current land-use policy needs for innovative soil processing technologies. We carried out a long-term field experiment on the Kastanozem in following options: moldboard plowing to a depth of 22 cm; chiselling to a depth of 35 cm; three-tier PTN-40 plowing to a depth of 40–45 cm; PMS-70 intra-soil milling of the 20–45 cm layer. Moldboard, chisel and three-tier plowing does not improve soil aggregate system. 20–45 cm soil layer milling by PMS-70 provides the formation of the 1–3 mm aggregates. 30–40 years after PMS-70 processing, the soil profile structure remained fine aggregate. Soil organic matter and dissolved organic matter content, as well as the soil productivity, were higher after PMS-70. New intra-soil milling machine PMS-260 was developed. The moldboard plowing did not change the natural soil profile vertical morphological differentiation. The soil loosening effect was short-term after soil chiselling. After the three-tier PTN-40 plowing, a large part of humus horizon material strews down the soil profile between the chaotically spread large structural blocks of illuvial and transitional horizons. After PMS-70 processing, the content of 1–3 mm size aggregate particle fraction in the illuvial horizon was triple compared to the three-tier PTN-40 plowing. The soil desalination was intensive after PMS-70. The absorbed Na⁺ content in solonetz was about 18–20% of soil cation exchange capacity (CEC) in the moldboard option. The same was after the chiselling. The CEC Na⁺ content was of 14–16% after the PTN-40. The CEC Na⁺ content was of 10–12% after the PMS-70. The SOM content in the 0–20 cm soil layer was 2.0%, in the 20–40 cm layer of 1.3%; the DOM content was 0.03% and 0.02% respectively in moldboard plowing option. The SOM and DOM content increased slightly in a period 3–4 years after chiselling. The SOM content was 2.2% in the 0–20 cm, and 1.4% in the 20–40 cm; the DOM content was 0.04% and 0.03% respectively after the PTN-40. The SOM content increased to 3.3% in the 0–20 cm soil layer, and to 2.1% in the 20–40 cm layer; the DOM content increase was 0.05% and 0.04% respectively after the PMS-70. In the moldboard option, the rhizosphere developed only in the upper soil layer of 0–20 cm. The rhizosphere spreads through

the soil crevices after chilling. The conditions of rhizosphere development were better in the local comfort zones of the soil profile after three-tier PTN-40 plowing. The rhizosphere developed well and uniformly both in the upper 0-20 cm and in the 20-45 cm layer after intra-soil milling by PMS-70. Improved plant growing conditions provide higher plant resistivity to pathogens. The technology life cycle profitability: moldboard 21.5%, chiseling 6.9%, three-tier 15.6%, intra-soil milling 45.6%. The new design of intra-soil milling machine provides five times less traction resistance; 80% increased reliability, halving energy costs. Intra-soil milling provides long-term land-use prospects.

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