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The impact of soil compaction and freezing-thawing cycles on soil structure and yield in Mollisol region of China

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Agricultural machinery tillage and alternating freezing and thawing are two critical factors associated with soil structure change and accelerates soil erosion in the black soil region of Northeast China. Combining practical machinery operation and natural freeze-thaw cycles with artificial machinery compaction in the field and artificial freeze-thaw cycles in the lab, the plus and minus benefits of machinery tillage, characterization of seasonal freeze-thaw cycles, and their effects on soil structure and yield were studied. Firstly [U+FF0C] the effects of machinery type and antecedent water content on soil structure and soil available nutrient were investigated by measuring soil bulk density, soil strength, soil porosity, soil aggregate distribution and stability, and three soil phases. The results showed that: Machinery tillage had positive and negative influence on soil structure, soil in top cultivated layer can be loosened and ameliorated however the subsoil accumulation of compaction was resulted. For heavy and medium machinery, subsoil compaction formed in the soil depth of 41∼60cm and 31∼40cm, respectively; however during the soil depth of 17.5∼30cm under medium machinery operation there was a new plow pan produced because of the depth difference between harvesting and subsoiling. Antecedent water content had a significant effect on soil structure under machinery operations. Higher water antecedent resulted in deeper subsoil compaction at 40cm [U+FF0C] which was deeper by 10cm than lower water content and soil compaction accumulation occurred at the first pass under higher water content condition. Besides water content and bulk density, soil organic matter is another key factor for affecting compressive-resilient performance of tillage soil. Secondly, based on the soils sampled from fields of the black soil region, the effects of freeze-thaw cycles on soil structure at different soil depths (0—40 cm, 40—80 cm, 120—160 cm) and size scales (field core sampling scale of seasonal freeze-thaw cycles, computerized tomography [CT] scale of artificial freeze-thaw cycles, and scanning electron microscope [SEM] scale of artificial freeze-thaw cycles) were studied. The results showed that: At three scale of seasonal freeze-thaw cycles, soil structure of sub soil (40—80 cm) changed more significantly comparing to the top soil and underling soil, this may be contributed by the higher clay content in soil. Soil compaction accelerated and subsoiling relieved dynamics condition of seasonal freezing and thawing process, resulting to a deeper and a lower frost depth, respectively. Soybean yield was not changed by compaction or subsoiling, or their interaction effects; however, interestingly hundred-gain weight of soybean increased after appropriate compactions but decreased when subsoiling was implemented on compacted soil.