Response of soil physical properties to tillage and straw management on two contrasting soils in a cryoboreal environment

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ABSTRACT

In view of their potential benefits, reduced or no tillage systems are being advocated world-wide. Concerns about impairment of some soil conditions, however, cast doubt on their unqualified acceptance. We evaluated the effects of 5 years of tillage-straw practices on bulk density, penetration resistance, aggregation and infiltration rate of a Black Chernozemic soil at Innisfail (loam, 65 g kg^{-1} organic matter, Udic Boroll) and a Gray Luvisol soil at Rimbey (loam, 31 g kg^{-1} organic matter, Boralf) cropped to spring barley in a cool temperate climate in Alberta, Canada. The treatments comprised combinations of two tillage methods: no tillage (NT) and conventional tillage (T), and two straw levels: straw removed (-S), and straw retained on the surface (+S). Each year, the T plots were rototilled three times to about 10 cm depth. All the plots were seeded using 2 cm wide disc type openers on drill. Bulk density (Db) of the 0-7.5 and 7.5-15 cm depths was significantly greater in NT plots (between 1.13 and 1.58 Mg m^{-3}) than in T plots (between 0.99 and 1.41 Mg m^{-3}) in both soils, irrespective of straw management. In Black Chernozemic soil, NT treatment had significantly greater penetration resistance (PR) than T treatment up to 15 cm depth. Straw retention significantly reduced PR of the 0-10 cm soil in NT plots but such effect in T plots was small. In the 0-5 cm depth of Black Chernozemic soil, the >2 mm fraction of dry aggregates was highest in the NT+S treatment (72%), followed by NT-S (66%), T+S (56%) and T-S (50%). The wind-erodible fraction (aggregates <1 mm size) was smallest (18%) in NT+S and largest (39%) in T-S treatment. Such values for NT-S and T+S were 23 and 33%. Soil aggregation benefited more from a reduction in tillage than from straw retention. Proportion of wind-erodible aggregates was generally greater in Gray Luvisol soil than in Black Chernozemic soil. In Black Chernozemic soil, average steady-state infiltration rate (IR) was significantly smaller (33%) in NT plots than in T plots. Straw retention improved IR in both NT and T treatments. In Gray Luvisol soil, IR was not significantly affected by the treatments. In summary, elimination of tillage and straw retention generally improved aggregation and infiltration while bulk density and penetration resistance were within desirable range for plant growth.