Long-Term Tillage and Cropping Systems Influences on Soil Hydrologic Properties

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INTRODUCTION

- Land use and management practices influence soil aggregation and stability, water retention and infiltration.
- A large amount of antecedent SOC pool is lost upon conversion from natural to agroecosystems (Lal, 2004).
- Therefore, no-till (NT) is being promoted as an alternative to the conventional tillage (CT) system partly to minimize losses of SOC and N pools, and improve soil aggregation and hydrologic properties.
- The NT practices conserve the soil and water, decrease soil bulk density, and improve water retention as compared to CT.

.Objectives

- Assess the effects of tillage and cropping systems influences on soil moisture retention, pore-size distribution, and water infiltration, in comparison with the undisturbed ecosystems.

MATERIALS & METHODS

- The long-term experimental site, initiated in 1964 is located at the Ohio Agricultural Research and Development Center, Wooster, OH (40°25'N, 83°15'W).
- Research plots are 22.3 x 4.30 m size with the long dimension up and down the slope (2-4%).
- Soils at the experimental site are classified as Wooster series (mixed, mesic, Typic Fragiudalf), and are well drained and silt loam in texture. The mean annual temperature is 9.1°C, and mean annual precipitation is 905 mm.
- Treatments consisted of : three tillage [NT, minimum-(MT), and CT] and two cropping rotations [continuous corn (*Zea mays* L.) (CC), and corn-soybean (*Glycine max* L.) (CS)], and undisturbed woodlots (WL).
- Ponded double ring infiltration measurements (n = 21) were conducted during July 2011 from all the treatments, and nearby WL areas in three replications.
- Intact soil cores (n = 84) of 5.35 cm diameter and 6.0 cm length were also collected with a core sampler from different tillage plots, and woodlot areas from four (0-10, 10-20, 20-30, and 30-40 cm) depths.

RESULTS & DISCUSSION

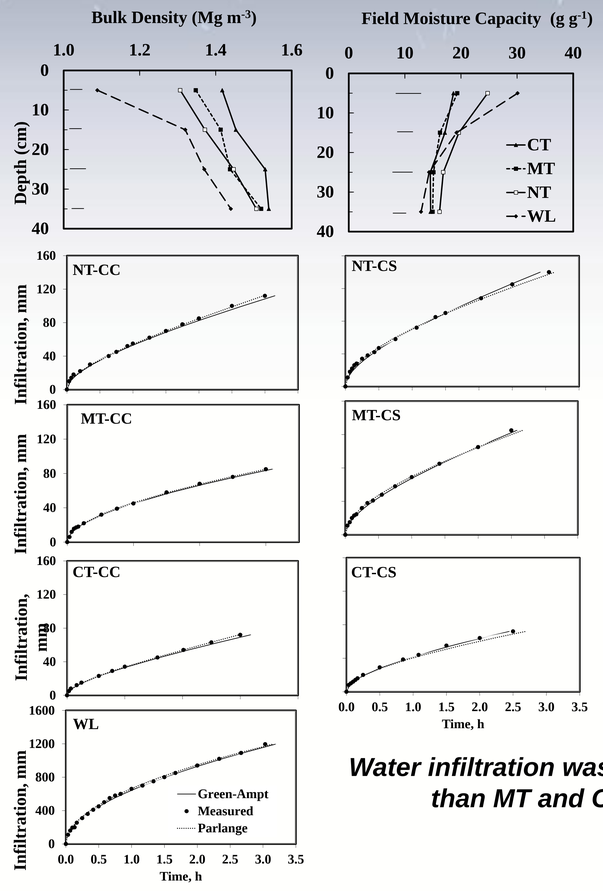

Fig. 1. Soil bulk density (ρ_b) and field moisture capacity (FC) as influenced by tillage systems.

Fig. 2. Water infiltration as influenced by different tillage and cropping sequences for the typical replicate. Note that two physical models were fitted to the measured infiltration data.

Water infiltration was higher under NT than MT and CT systems

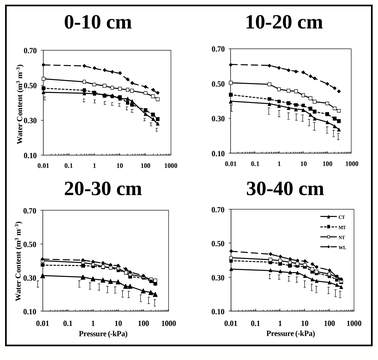

Fig. 3. Soil water retention at 0-10, 10-20, 20-30, and 30-40 cm depths in different tillage systems.

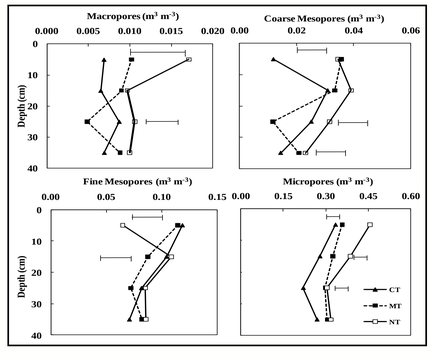

Fig. 4. Macropores, coarse mesopores, fine mesopores, and micropores as influenced by different tillage systems.

- The NT system has 8 and 3% lower bulk density (ρ_b) than that under CT and MT, respectively.
- Lower ρ_b values are partially attributed to that more crop residue accumulated in the surface soils of NT plots which promote the soil aggregation and bioturbation.
- Field moisture capacity was higher for NT than MT and CT systems.
- The quasi-steady state infiltrate rate (q_s) was significantly higher under NT (34.7 mm h^{-1}) than MT(19 mm h^{-1}) and CT (8.21 mm h^{-1}). The q_s was higher for CS than CC cropping system.
- Green-Ampt and Parlange models fit the measured infiltration data reasonably well (r^2 = 0.91 to 0.98). Fitted *sorptivity (S)* and *saturated hydraulic conductivity* (K_s) parameters were the highest for the NT system.
- Soil water retained (SWR) at 0 kPa in the 0-10 cm depth was 17 and 13% higher in NT than CT and MT systems, respectively.
- Soil under NT had higher proportion of macro-(>1000 μm) and micro-(<10μm) pores than that under CT and MT.

CONCLUSION

- Results show that long-term NT practices decreased soil ρ_b and improved the field moisture capacity in comparison to CT and MT systems.
- Soils under NT systems have improved macro-and micro-pores which in-turn increased soil water retention and water infiltration.
- Soil properties were better under CS than CC rotation.

ACKNOWLEDGEMENTS

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Reference

- **Lal, R. 2004. Soil carbon sequestration impacts on global climate change and food security. Science 204:1623-1627.**

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USDA United States Department of Agriculture National Institute of Food and Agriculture