

Long-term Tillage, Straw and N Rate Effects on Quantity and Quality of Organic C and N in a Gray Luvisolic Soil

S. S. Malhi^{1*}, M. Nyborg², E. Solberg³, J. DeMulder³, Z. Zhang³, Z. H. Wang¹ and D. Leach¹

¹Agriculture and Agri-Food Canada, Research Farm, P.O. Box 1240, Melfort, Saskatchewan, Canada S0E 1A0

²Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada T6G 2E3; and

³Alberta Agriculture, food and Rural Development, Crop Diversification Centre North, R.R. 6, 17507 Fort Road, Edmonton, Alberta, Canada T5B 4K3

*Phone: 306-752-2776 Ext 230; Fax: 306-752-4911; E-mail: malhis@agr.gc.ca;

ABSTRACT

The objective of this study was to determine the effect of tillage, straw and N rate on total organic C (TOC) and N (TN), light fraction organic C (LFC) and N (LFN), mineralizable C and N, biomass C, macro organic matter C (MOM-C) and N (MOM-N), pH, extractable P and nitrate-N in a Gray Luvisolic soil after 19 years. Tillage patterns, straw managements and N application showed marked influences on soil organic C and N. The TOC in 0-30 cm layers was significantly increased by ZT or N addition, and with the increase of N rates, the TOC showed obviously increase in the 0-7.5 and 7.5-15 cm soil layers. However, marked increase of TOC in straw returned treatment only occurred in the 0-15 cm soil layers. Zero tillage markedly increased the mass of TN in the 0-40 cm layers, while straw retention and N application only significantly increased soil TN in the layers from 0 to 30 cm soil depth. Soil LFC in the 0-15 cm layer was significantly increased with elimination of tillage or retaining straw, but it was only significantly increased in 0-7.5 cm soil layer by application of N. Increase of N rate did not lead to further increase of LFC in soil. Elimination of tillage, retention of straw and application of N markedly increased soil LFN in the 0-15 cm layer, and the soil LFN also increased with the increase of N rates. The percentage of LFC to TOC and that of LFN to TON are important natures of soil organic matter. Higher percentages imply that the organic matter is easy to mineralize more C and N to soil. Zero tillage showed no effect on the percentages, but removing straw significantly decreased the percentages. Application of N tended to increase the percentages, especially in 0-7.5 cm soil layer. The mass of mineralizable C was markedly increased by ZT and straw retention in 0-7.5 cm soil layer. Application of N increased mineralizable C in 7.5-15 cm soil layer, but it did not show any further increase when N rate increased from 50 to 100 kg N ha⁻¹. The mass of mineralizable N was significantly increased by ZT or application of N in the 0-15 cm soil layer, and increase of N rates tended to further increase the mineralisable N, especially in the 7.5-15 cm soil layer. Straw retention also increased soil mineralizable N, but the increase was only significant in the 0-7.5 cm layer. Zero tillage or application of N fertilizer tended to decrease biomass C in most cases, but straw retention tended to increase biomass C. Zero tillage also decreased the soil MOM-C in the 0-7.5 cm layer, but showed no effect in the 7.5-15 cm soil layer. Retention of straw and application of N markedly increased the MOM-C in the 0-15cm soil layers. Soil MOM-N was not influenced by tillage method, straw management or application of N fertilizer. There was some depression in soil pH in the 0-15 cm layer with N application, while tillage and straw treatments had little effect on soil pH. Soil extractable P in the straw retention or ZT treatment was markedly higher than that in straw removal or CT tillage treatment. However, it was significantly decreased by application of N, especially in the 0-7.5 cm layer, and this is most likely due to the increased crop production with N application and subsequent P uptake. Nitrate-N level was quite low in soil in all treatments. Nitrate-N in 0-15 cm soil layer was increased only by 0.6–1.4 kg N ha⁻¹ with N addition, and tillage and straw management had no effect on soil nitrate-N.