Mineralization of ^{14}C-labelled plant residues and microbial assimilation in conventional tillage and no-tillage systems

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Introduction

Tillage practices cause changes in soil C dynamics through their influence on soil biological properties and quality and quantity of soil organic matter. The aim of this study was to investigate long-term tillage system influences on metabolic capacity of soil microbial community, separate from tillage effects on the overall quantity, quality or distribution of native soil organic matter, using addition of radiolabelled wheat residues.

Fig.1. Fourteen years of conventional tillage and no-tillage winter wheat–corn–soybean rotation at Woodslee Research Station, Ontario, Canada (42° 13' N lat., 82° 44' W long.).

Materials and methods

Intact core samples were collected from 0-5 cm for conventional tillage (CT) and from 0-5 and 10-15 cm for no-tillage (NT) in May 2007 before fertilizer application and corn planting (Fig. 2.). For each tillage and soil depth, The ^{14}C-labelled wheat residues were applied either on the surface or incorporated into the soil (3×2 factorial design). Cores were incubated at 25ºC for 86 days and cumulative carbon mineralization was then determined by trapping CO_2 in alkali (Fig. 3 and 4). Soil mineral N concentration (SMN) and microbial biomass ^{14}C ($MB^{14}C$) were measured on four occasions.

Fig. 2. Conventional tillage verses no-tillage plots. Woodslee ON, Spring 2007

Fig. 3. Each core was incubated at 25ºC in a l000 mL Mason jar together with a CO_2-trap (10 ml 2*M* NaOH).

Fig. 4. Weekly aeration of incubated Mason jars.

Results

After 86 days from addition of ^{14}C-labeled wheat residues, 7 to 11% of added residues were respired as CO_2-^{14}C by soil microbial biomass. Greater cumulative respired CO_2-^{14}C (10%) and potentially mineralizable ^{14}C ($^{14}C_0$) (20%) at 0-5 cm was measured in CT compared with NT across residues application methods (Fig. 5). There was no significant residue placement or sampling depth effect or their interaction effects on cumulative respired CO_2-^{14}C and $^{14}C_0$. Microbial biomass ^{14}C accounted for 0.4 to 5% of the ^{14}C derived from wheat residues. Incorporation of residues with soil resulted in 39% greater $MB^{14}C$ and 61% greater qCO_2-^{14}C compared with surface application of residues averaged across sampling dates, tillage systems and sampling depths.

Higher soil mineral N values were measured at the surface and with surface placement of residues compared with 10-15 cm depth and incorporated residues.

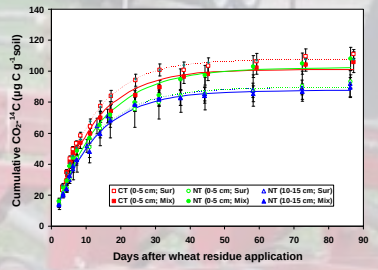

Fig. 5. Residue-derived CO_2-^{14}C evolved during an 86 d incubation at 25ºC after addition of ^{14}C-labeled wheat residues by surface application or incorporation.

Conclusion

A greater ratio of MBC:SOC under NT than under CT suggests higher quality of SOC under the NT system.

Microbial community under CT was more metabolically active than the community under NT, similar to the results reported by Wander and Yang (2000), Balota et al. (2004) and Zhang et al. (2007).

The magnitude of the differences in metabolic capacity between these two systems was small.

Previously observed differences in respiration and size of the microbial biomass can be likely taken to be primarily a function of quality and quantity of the soil organic matter rather than differences in metabolic capacity.

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