



Soil Organic Carbon Labile Pools for Soil Profiles after 17 Years of Continuous No-tillage



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Objectives

1. Characterize labile pools (LPs) of soil organic carbon (SOC) throughout soil profile (0-1.53 m) using long-term incubations. 2. Model mean residence time (MRT) of LPs. 3. Correlate modeled active SOC with chemical method of Permanganate oxidizable C (POXC).



Results

• Soil total C, N, C/N, pH, ¹³C-SOC, and bulk density by soil depth



Highlights

Estimated LP1 and LP2 size declines with soil depth in profile, but only accounts for about 1% and 3.6% of total SOC. LP3 size is at least three times larger than LP2 and accounted for more than 12% of total SOC in each depth. Labile pool size in subsoil was less than surface depths, but comprised a greater fraction of total SOC.

Active SOC pool sizes from optimized model provided MRTs of 5 days (LP1), 60 days (LP2) and 2 years (LP3) and agree with other studies (Collins et al., 2000; Crow and Sierra, 2018; Knorr et al., 2005; Zacháry et al., 2018)

Fig. 1. Conceptual diagram of SOC fractions and MRT. **Materials and Methods**

• Soil sampling and analyses

Following 17 years of continuous no-tillage, soil cores were collected in 10cm increments to a depth of 30-cm and then by soil horizon to 1.53 m at 25 field locations representing typical soil series at the Cook Agronomy Farm Long-term Agroecosystem Research site near Pullman, WA. Total soil carbon, nitrogen and ¹³C-SOC were determined with an elemental analyzer coupled with an isotope ratio mass spectrometer (EA-IRMS); pH by 1:1, soil: water; bulk density after drying at 105°C for 24 hours; and permanganate oxidizable C (POXC), Weil et al.(2003).

Soil carbon mineralization

Soil from all depths and locations were incubated for 350 days at 21°C and

Fig. 4. SOC (A), total nitrogen (B), C/N ratio (C), pH (D), ¹³C-SOC (E) and bulk density (F); p=0.05.

Soil carbon mineralization



Fig. 5. Example of soil respiration over time for 0-10 cm (a) and 97-122 cm (b). Red line is the fitting curve of three carbon pool model with fixed optimized kinetic parameters.

Fig. 6. Total mineralized SOC after whole incubation period (a) and mineralized carbon percentage over total organic carbon (b); p=0.05.

*Different SOC pools are simplified in the conceptual diagram below (Fig8) and could provide basis for process-oriented modeling. The percentage in red is based on total carbon concentration using means from all depths.

1: LP1 (MRT=5 days), 1.4%; 2: LP2 (MRT= 60 days), 4.4%; 3: LP3 (MRT= 2 years), 18.6%; 4: POXC, 2.3%; 5: TMC (Total mineralized C), 11%; 6: Slow carbon ,75.6%

Estimated LP1size is about 40% of POXC, and LP2 size is very close to POXC. The correlation, however, was weaker when LP2 size was greater than 700 mg C/kg soil. POXC accounted for 17.2% of total mineralized carbon.

25% water in the dark (Fig2a). Base trap method and two-end point titration used to determine evolved CO_2 (Fig2b).



Fig. 2. Laboratory incubation (a) and titration (b).

• Modeling labile pools and mean residence time



(µg CO₂/g soil / day); k1, k2 and k3 (day⁻¹) are mineralization rate constants for different carbon pools; C1, C2 and C3 are mineralized carbon pool sizes

- Soil carbon pools estimated by optimized kinetic parameters
 - Table 2. Modeled SOC pool size (LP1 with MRT= 5 days, LP2 with MRT=60 days, LP3 with MRT= 2 years) and fraction (F1, F2, F3) by soil depth.

Depth	No. of	SOC pool size (mg C/kg soil)				SOC labile pool fraction (%)		
(cm)	samples	LP1	LP2	LP3	Slow C	F1	F2	F3
0-10	25	192.7±8.8 a	801.9±51.4 a	4784.5±186 a	14886.7±730 a	0.959±0.074 b	3.996±0.282 b	23.61±0.976 a
10-20	25	105.4±4.8 bc	473.8±16.6 b	2230.9±114 b	11774.2±682 b	0.759±0.056 b	3.385±0.162 b	15.81±0.85 ab
20-30	25	131±5.6 b	364.8±14.8 c	1205.1±60 c	11078±948 b	1.210±0.151b	3.246±0.291 b	11.91±1.955 b
>30	105	104.6±4.1 c	269.8±11 d	849±44 d	4477.9±405 c	2.911±0.232 a	7.945±0.687 a	21.74±1.656 a
Notes: The data was expressed as mean± standard error. The small case letter is annotating the significance level (p=0.05) of pool size								
across the four depth.								

Correlation between estimated SOC pools and POXC and mineralized carbon



References

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