CO_2 Flux from a Japanese Tropical Soil Applied with Glucose and Starch

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SOM Decomposability and Carbon Flux Behavior

Soil respiration, carbon dioxide (CO_2) flux from soils to the atmosphere, is major flux in global carbon dynamics[1]. The carbon flux is occurred through the biological decomposition of soil organic matters (SOM)[2]; however the measurement of the SOM decomposition rates, or decomposability has not been clearly defined yet. The C:N ratio or molecular weights have been applied for complex SOM such as litters as an indicator of the rates, however, they may not be applied to identify the decomposition similarities between glucose and starch, since the starch is basically constituted of (α-) glucose by glycosidic bond.

Objectives for the study

- To assess the SOM decomposability by an alternative measurement using slopes of cumulative soil respiration
- To elucidate the carbon flux behavior from the soils applied with mono-saccharide (glucose) and poly-saccharide (starch).

Hypotheses

HYPOTHESIS 1:
The decomposability of glucose and starch measured by CO_2 respiration would be similar because their basic components are glucose.

HYPOTHESIS 2:
The time lag between glucose and starch in CO_2 respiration would occur due to time required to break down starch into glucose.

Experimental Soil and Amendments

- Tropical acid soil, called Kunigami-mahji
  - Sampling location (Fig. 1)
  - Fallow soil (0-15 cm)
  - Sandy clay loam (Table. 1)
  - Oven dried (45°C) with 2 mm sieved passed
- Saccharides
  - Glucose (^{12}C, Alfa Aesar Ltd.)
  - Starch (^{12}C, Wako Ltd.)

Table 1. Selected properties of the soil used in this study

Property	Unit	Kunigami-mahji
pH		4.6
EC	μS/cm	34.4
TC	g/kg	1.12
TN	g/kg	0.15
TP	g/kg	0.26
H_2O-P	mg/kg	0.17
Truog-P	mg/kg	0.70

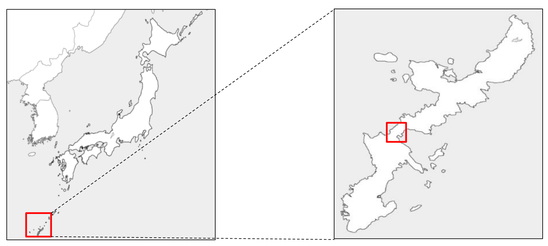

Fig. 1. Sampling location (●) of southern part of Okinawa Island in Japan (Data source: SIO, NOAA, U. S. Navy, NGA, and GEBCO, 2014)

Incubation Experiment & Alkali Trapping Methods

- Incubation Condition
  - 50 g of soil in 125 mL bottle placed inside of 1100 mL bottle
  - 30 °C of incubation temperature
  - 50% of the water holding capacity
  - Dark environment
  - 0.05, 0.5, 5% (w/w) input rates
  - 21 days of incubation period
- Alkali Trapping Methods[3]
  - CO_2 trapped by 1M NaOH (20 mL)
  - NaOH solution titrated by 0.2 M HCl
  - Unreacted HCl calculated by its titer (8.7×10^{-5} mol CO_2 mL^{-1})
  - Large container without soils as blank
- Saccharide Decomposability Measurement
  - Cumulative soil respiration rates (CSR_{max}) calculated
  - A half of CSR_{max} ($CSR_{max}/2$) determined
  - Sigmoid equation for CSR calculated
  - Time required to reach $CSR_{max}/2$ (T_m) determined

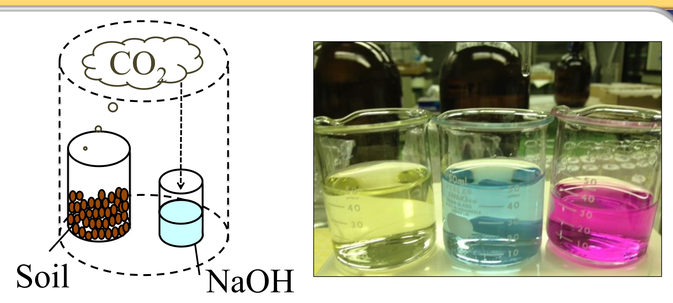

Fig. 3. Soil respiration test

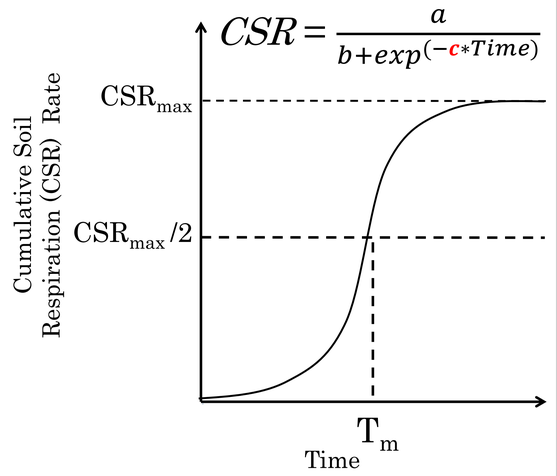

Fig. 4. Modified Sigmoid model for CSR rates

Results and Discussion

Table 2. Time required to reach half of the CSRmax (T_m) and initial slopes

Treatments	Input amounts	Equation coefficient			T_m
	%	a	b	c	Days
Soil only	n/a	6.0	0.0	0.7	4.5
Glucose	0.05	22.5	0.1	0.8	3.3
Glucose	0.5	94.5	0.0	0.8	3.9
Glucose	5	41.4	0.0	1.1	4.2
Starch	0.05	37.5	0.1	0.9	2.3
Starch	0.5	34.1	0.0	0.8	4.7
Starch	5	410.2	0.4	0.5	6.6

No any significant differences between equation coefficient

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The decomposability between glucose and starch was similar although the input rates were different (Hypothesis 1).

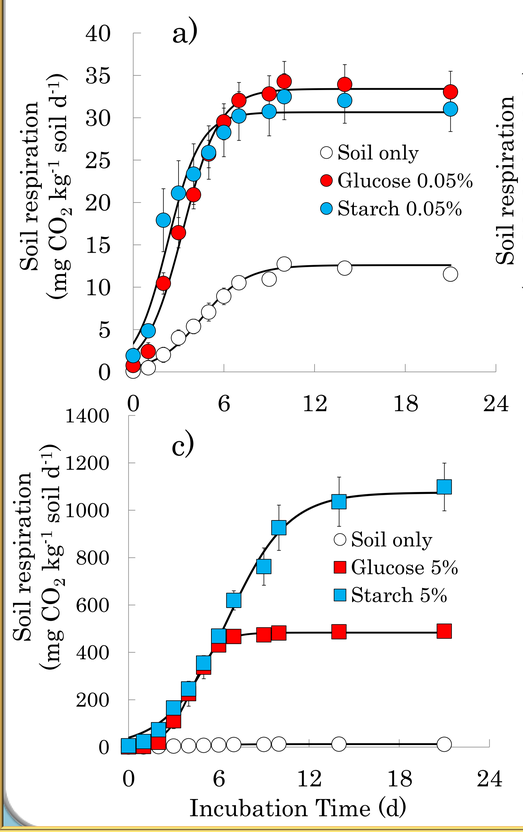

Fig. 5. Cumulative soil respiration rates applied with starch and cellulose during the incubation period (a,0.05%; b,0.5%; c,5%)

T_m of the soil with the least input rate (0.05%) of glucose was significantly smaller than the starch, although the smaller T_m of the soil with the most input rate (5%) of glucose rather than starch was observed.

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The time lag occurred possibly due to time required for starch to break down to glucose (Hypothesis 2).

Reference

1. Grunwald. 2008. UF SNRE-DED., 2. Vargas et al. 2011. Biogeochemistry. 102:1-13
3. Luo and Zhou. 2006. pg 161-185. MA. USA

Acknowledgements

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