Flush of CO_2 as a Soil Biological Quality Indicator

Alan J. Franzluebbers
United States Department of Agriculture - Agricultural Research Service
1420 Experiment Station Road,
Watkinsville GA 30677 USA
Contact: afranz@uga.edu, 1-706-769-5631

Richard L. Haney
United States Department of Agriculture - Agricultural Research Service
808 East Blackland Road,
Temple TX 76502 USA
Contact: rhaney@spa.ars.usda.gov, 1-254-770-6503

Background

Soil microbial biomass is an active part of soil organic matter that plays a key role in the decomposition of organic materials, nutrient cycling, formation of soil structure.

Measurement of soil microbial biomass has been proposed with a number of biochemical procedures, which vary in their sensitivity, procedural complications, and relationship to other active soil organic matter fractions.

Across a number of soils, the flush of CO_2 following rewetting of dried soil was closely related to:
(1) the flush of CO_2 following fumigation with chloroform
(2) potential C mineralization
(3) potential N mineralization
(Franzluebbers et al., 2000).

Both chloroform fumigation-incubation and rewetting of dried soil utilize the activity of the surviving native soil microbial community to evaluate the soil microbial biomass.

Objective

Describe how the flush of CO_2 can be used to discriminate changes in soil biological quality induced by various agricultural management practices under different soil conditions.

Incubation Vessel

----- Materials and Methods -----

Soil analyses followed the procedures outlined in Franzluebbers et al. (2000) from oven-dried (55 C, 48 h) and gently crushed (<4.75 mm) samples.

Carbon mineralization was determined at 3, 10, and 24 d from moistened soil (50% water-filled porosity, 25 C) incubated in 1-L canning jars with alkali to absorb CO_2.

Soil microbial biomass C was determined with chloroform fumigation-incubation without subtraction of a control.

Net N mineralization was determined from inorganic N at 0 and 24 d of incubation.

Soil organic C and N were determined from dry combustion for soils with pH < 7 or sulfuric acid-dichromate and Kjeldahl digestion with higher pH.

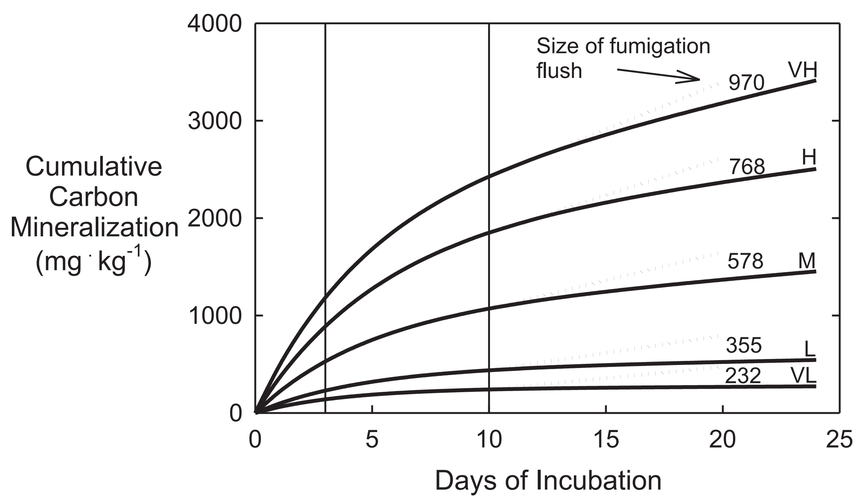
Evaluation 1: Soils (0-10 cm) from Oklahoma (10 soils under wheat), Texas (2 soils under maize-wheat), Maine (2 soils under cereals), and Idaho (1 soil under potato). pH from 5.1 to 8.3.

Evaluation 2: A clay loam subsoil and loamy sand overwash from Georgia; planted to tall fescue-endophyte associations for 8, 20, 36, and 60 weeks.

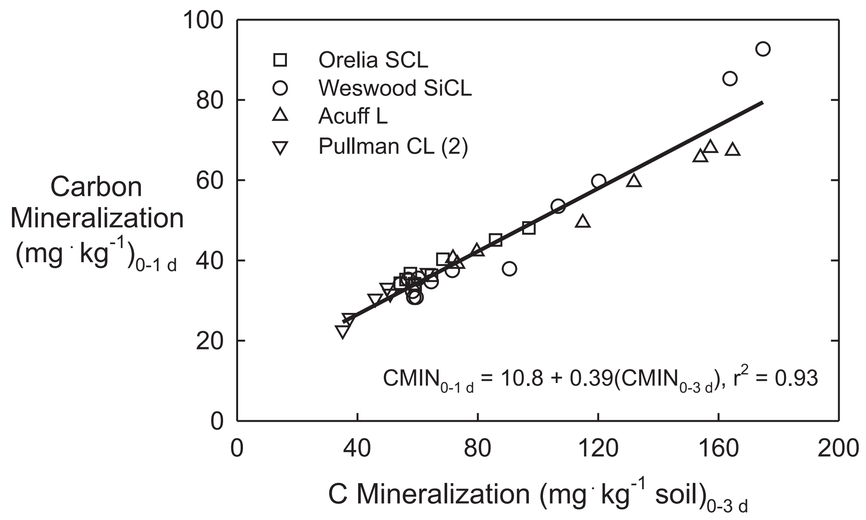
Evaluation 3: A soil from North Carolina sampled for 5 years under 3 maize silage intensities at depths of 0-3, 3-6, 6-12, and 12-20 cm.

Franzluebbers AJ, Haney RL, Honeycutt CW, Schomberg HH, Hons FM. 2000. Flush of carbon dioxide following rewetting of dried soil relates to active organic pools. *Soil Science Society of America Journal* 64, 613-623.

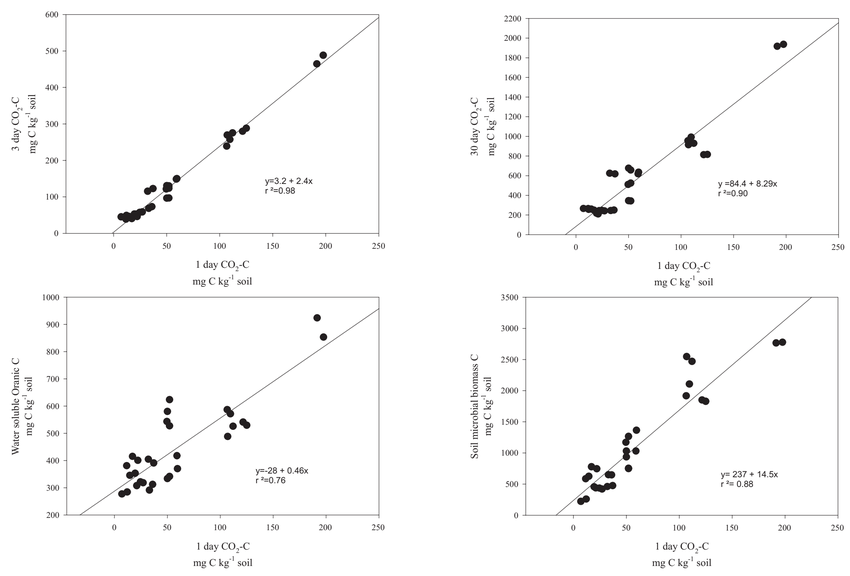
----- Results -----



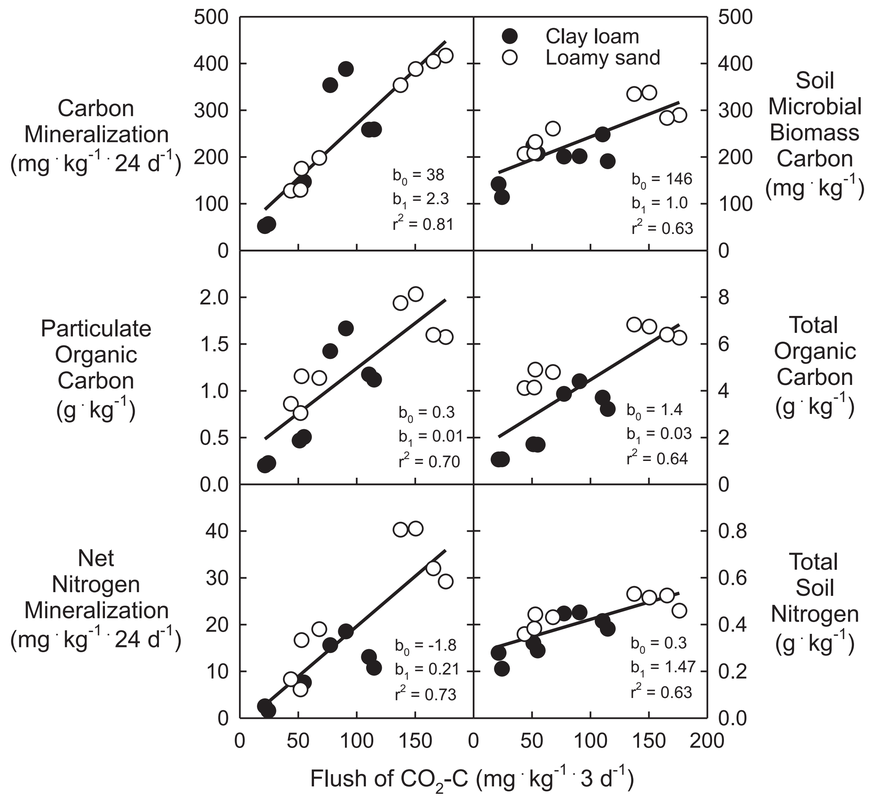
Soils with a high flush of CO_2 following rewetting also had a high flush of CO_2 following chloroform fumigation.



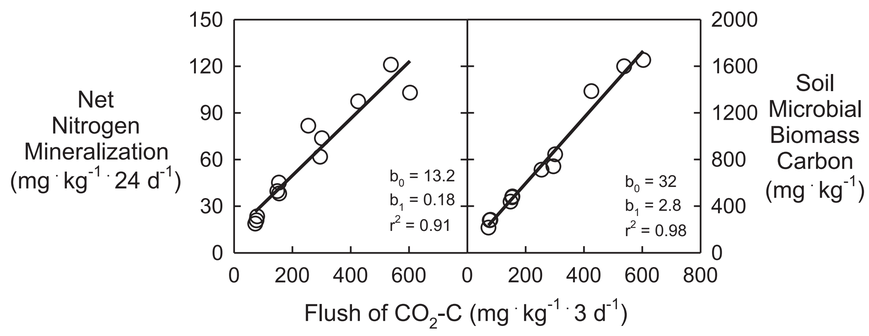
Differences in soil microbial activity could be distinguished whether the flush of CO_2 was determined from 1 or 3 d of incubation.



Evaluation 1: The flush of CO_2 was related to readily available, biologically active, and microbial biomass C.



Evaluation 2: The flush of CO_2 was highly related to other C and N fractions during the growth of tall fescue, suggesting that it is a robust indicator during the active growth cycle of plants.



Evaluation 3: Development of active soil C and N fractions with time were readily predicted with the flush of Co_2 .

----- Conclusions -----

The flush of CO_2 following rewetting of dried soil exhibited strong relationships with biologically active soil C and N fractions, including water-soluble organic C, potential C mineralization, net N mineralization, and microbial biomass C.

The relatively simple, rapid, and reliable methodology makes the flush of CO_2 a viable tool for soil testing of biological soil quality under a diversity of conditions.

Presented at the 17th Conference of the International Soil Tillage Research Organization from 28 August to 3 September 2006 in Kiel, Germany.