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CFAES

Management effects on soil respiration under on farm conditions in Stark County, Ohio

Baldarelli, L.M[1]., Neikirk, H.A[2]., and Lal, R[3].

1. Post Doctoral Scholar, Stark Sustainable Soils Initiative, CFAES Rattan Lal Center for Carbon Management and Sequestration, The Ohio State University, Columbus, Ohio, USA (baldarelli.1@osu.edu)
2. Extension Educator, Agriculture and Natural Resources, The Ohio State University Extension, Stark County, Massillon, Ohio, USA (neikirk.2@osu.edu)
3. Distinguished Professor of Soil Science and Director, CFAES Rattan Lal Centr for Carbon Management and Sequestration, The Ohio State University, Columbus, Ohio, USA (lal.1@osu.edu)

STARK SUSTAINABLE SOIL INITIATIVE

OBJECTIVE

We sought to determine the effects of three different farming practices (tilling, fertilizer usage and cover cropping) on microbial activity (measured via CO_2 burst) on 12 farms experiencing a humid continental climate in the Midwest region of the United States.

BACKGROUND INFORMATION

Agricultural soil not only connects us to the food that we eat, but it has the potential to be one of the largest carbon sinks helping to mitigate climate change. Farm management techniques play a considerable role in the soils ability to sequester carbon and retain nutrient availability.

In general, no-till systems tend to increase soil carbon and overall microbial activity. Manure has been shown to improve soil health by increasing soil organic matter content and microbial activity. Cover cropping is another conservation farm practice that can maintain soil nutrients and increase overall soil health while decreasing nitrate pollution and reducing the risks of soil erosion during the nongrowing season.

There are a growing number of farmers opting to use this more holistic approach to managing their lands and conserve soil. However, on-farm studies regarding these topics are still relatively limited. In order to increase adoption of these conservation practices, it is important to increase awareness about the soil health dynamics especially among local communities.

We predicted that: no-till (NT) fields, manure usage and cover cropped lands would have the greatest microbial activity (or evolved CO_2), compared to tilled fields.

STUDY DESIGN

- Twelve farms were selected during 2020 within Stark County, Ohio (Fig. 1).
- All participating farmland soils are classified as Canfield Silt Loam (55% silt, 31% sand, and 14% clay).
- Soybeans (*Glycine max*) were the most common crop grown in 2023 with two farms of field corn (*Zea mays*), one oat (*Avena sativa*) and the remaining farms continued to grow long-term forage hay fields (Fig. 1).
- As a reference, soil from two wooded areas adjacent to two of the selected farms were also collected (Fig. 1).
- Five sites were selected at each farm and wooded sites for measuring soil respiration (potential soil microbial activity).

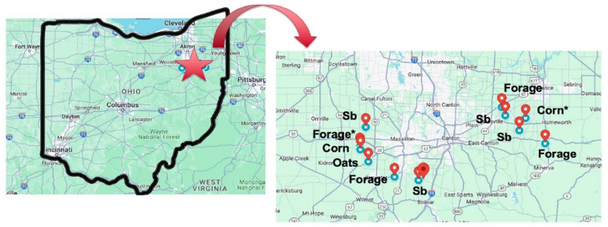

Figure 1. The distribution of the twelve participating farms within Stark County, Ohio. All of the farms are labeled with their 2023 grown crop and reference wooded sites are indicated with an asterisk. (Sb = soybean)

METHODOLOGY

At each of the five farm/wooded sites, six soil cores were obtained from the top 0-15 cm. Samples from these cores were air dried, gently ground and sieved through a 2-mm mesh.

Potential soil microbial respiration (released CO_2) that can give us an indication of overall soil health, was estimated using the incubation method that measures evolved CO_2-C after 24-h (Fig. 2).

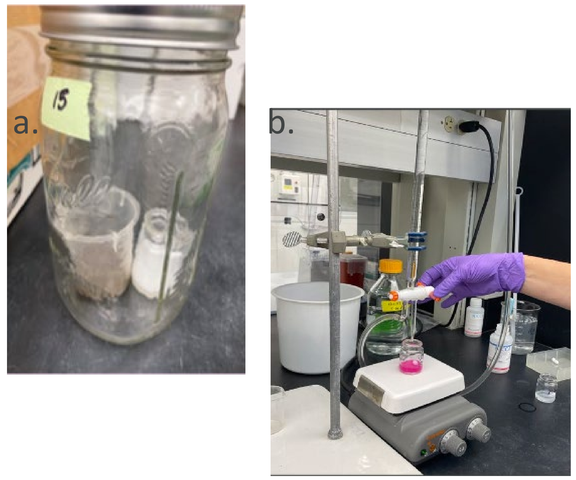

Figure 2. (a) The incubation setup including air-dried soil (20g), the CO_2 trap and water to wet the soil and activate the microbes. We had a jar setup for each of our sites at all 12 of our farms. (b) The titration station experimental step that allows us to determine the amount of CO_2 respired from the microbes at each of the sites per farm. Each trap (shown above) was titrated to a pH of 7 (indicated by pink).

RESULTS / DISCUSSION

- There were no significant effects of tillage (Fig. 3) or fertilizer (Fig. 4) on CO_2 evolution. However, the long-term hayfields ('Hay') had the highest amounts of CO_2 evolved, followed by no-till systems ('NT') (Fig. 3), suggesting that tillage of any kind can have negative implications on microbial activity and overall soil health.
- CO_2 values (our proxy for microbial activity), were significantly greater in soils where cover crops were used, compared to the soils that did not include cover crops (Fig. 5).

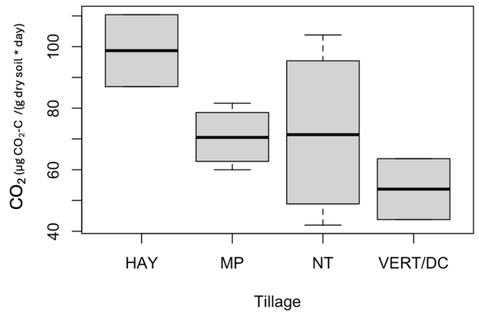

Figure 3. CO_2 values in in hay fields ('Hay'), conventionally plowed fields ('MP'), no-till fields (NT) and conservationally-tilled fields ('VERT/DC') (p = 0.23). The bold black lines indicate the medians, the boxes represent the upper and lower quartiles, and the whiskers represent the reasonable extremes (1.5*IQR).

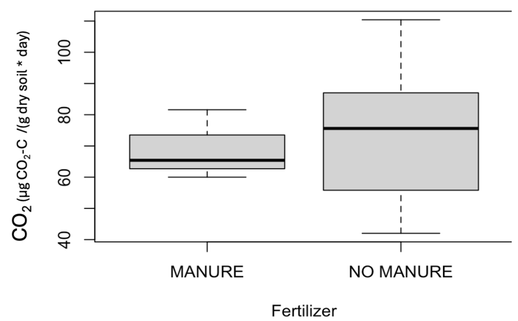

Figure 4. CO_2 values from farms that applied manure ('Manure') and from farms that did not apply manure ('No Manure') (p = 0.73). The bold black lines indicate the medians, the boxes represent the upper and lower quartiles, and the whiskers represent the reasonable extremes (1.5*IQR).

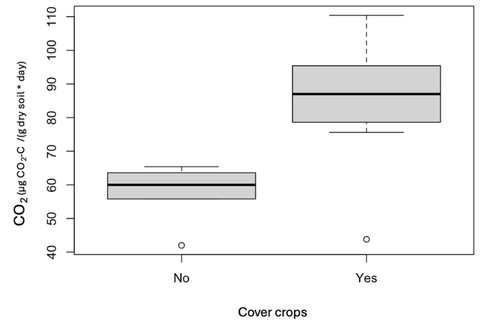

Figure 5. CO_2 values from farms that used cover crops ('Yes') and those that did not ('No') (p = 0.03). The bold black lines indicate the medians, the boxes represent the upper and lower quartiles, the whiskers represent the reasonable extremes (1.5*IQR), and the outliers (open circles) were calculated as Q3 + 1.5*IQR.

CONCLUSIONS

- Altogether these data suggest that although tilling and manure usage may not influence CO_2 values over short-term (one growing season) on-farm studies, cover crops are associated with greater CO_2 evolution, indicating greater microbial activity in these soils.
- Future studies may focus on farmers that implement similar management techniques (e.g., type/amount of manure, cover crop diversity, etc.) for better statistical representation of the data.
- It's important to continue to explore conservation farming practices across all regions with varying soil types to better understand the ecological benefits that can conserve soil worldwide.

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