Effects of Rainfall on Soil Respiration Rates in South Dakota Dryland Farm Ground

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Introduction

Research Question:
- How does variation in precipitation affect soil respiration in corn fields?
  - How may variation from seasonal averages affect this?
  - Does precipitation rates and/or totals affect this?

Motivation:
Identifying the correlation between precipitation and soil respiration can aid in better carbon sequestration modeling and carbon credit values as well as agricultural forecasting and crop rotation planning.

Methods and Sites

Data Retrieval:
- State Precipitation stations near selected sites (fields).
- Solvita Low-Level Carbon Detection Kit
- 14-day interval Soil Samples

Sites:
Site A – prone to more stratiform precipitation, typically early season rains
Site B – prone to scattered thunderstorms, high precipitation variability
Site C – prone to more severe thunderstorms, highest average rainfall total

Figure 1 - This satellite image shows the geographical locations of all 3 sites

Data and Discussion

- Precipitation was recorded daily by state weather stations within 5 miles of each site
- Precipitation was recorded in the 14 days before each test
- Carbon Dioxide (CO_2) sequestered is measured as Carbon (C) in the soil
- Carbon is an element used during normal plant activity and must be captured from the atmosphere as CO_2 and then converted where excess is put into the soil
- The general trend, as seen in Figure 2, shows that as precipitation increased (bar graph) soil respiration rates also increased (line graph)
- Differences in values come from field flooding at Site C and differing farming practices

Recorded Precipitation (inches)

	Site B	Site C	Site A
5/16/2024	0.490	0.709	0.490
5/30/2024	1.780	1.859	1.950
6/13/2024	0.980	0.499	0.910
6/27/2024	4.930	5.548	4.930
7/11/2024	1.490	0.619	1.490
7/25/2024	1.310	0.360	1.310
8/8/2024	0.090	0.739	0.090
8/21/2024	1.980	1.369	1.980
9/5/2024	1.210	0.830	1.210
9/19/2024	0.180	0.219	0.180
10/3/2024	0.000	0.050	0.130

Table 1 - This table shows the measured precipitation at the sites in between the test dates.

Soil lb/ac CO_2 - C

	Site B	Site C	Site A
5/16/2024	30.4	30.4	34.6
5/30/2024	31.3	28.6	30.4
6/13/2024	38.5	47.9	28
6/27/2024	54	28	16.3
7/11/2024	62.4	11	46.7
7/25/2024	38.5	28	16.7
8/8/2024	50.7	8.5	17.2
8/21/2024			
9/5/2024	54	19.6	25.7
9/19/2024	57.6	23.2	29.8
10/3/2024	21.3	8.5	12.4

Table 2 - This table shows the measured amount of short-term Carbon within the soil at the test dates.
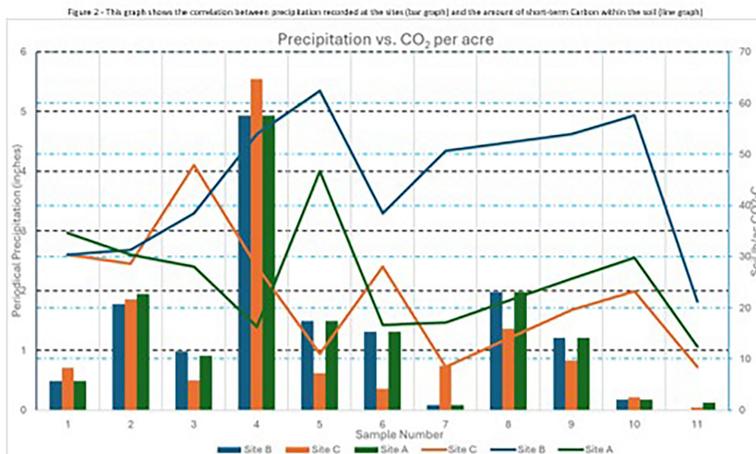

Figure 2 - This graph shows the correlation between precipitation recorded at the sites (bar graph) and the amount of short-term Carbon within the soil (line graph)

Precipitation vs. CO_2 per acre

Conclusions & Limitations

Conclusions:
- There is a strong correlation between precipitation and soil respiration rates
- Soil Respiration rates are at their peak during the peak of plant activity despite being below average precipitation (Samples 3,5,6,7)
- As the plants mature at the end of the growing season (end of the trial) soil respiration rates fall off
- When the soil is overly saturated soil respiration rates drop to near zero (Site C – Sample 5)

Limitations:
- Soil samples collected every 14 days can miss a lot of unseen activity
- Unable to truly track rainfall rates, only have *inches/day* instead of *inches/hour*
- Average location in a field does not always equal the field average as I had to assume

Future Work

- Add more sites to encapsulate differing farming practices and variability in precipitation
- Use a more advanced soil sampling product that has shorter intervals on the order of minutes to hours
- Investigate not only the daily precipitation rates but the hourly as well once paired with shorter soil sampling intervals
- Study the same field over years to find a more accurate trendline
- Use a grid analysis in both precipitation values and respiration rates to find the true field average

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