Analysis of Soil Samples for their Carbon Sequestration Abilities

Praneel Suvarna
New Jersey Institute of Nature

Abstract

Fifty-eight percent of soil organic matter is usually made up of carbon. This study uses the Loss-Of-Ignition procedure to calculate the amount of carbon in various soil samples. We compare the amount of soil organic carbon across at various depths across a 50 acre farm as well as 4 residential areas. A loss on ignition test burns the soil organic material in order to give us a rough estimate of the soil organic carbon in the soil. This is important to research into climate change as soil is the earth's largest terrestrial carbon sink and analyzing the amount of carbon in different types of soil can help us sequester carbon at a greater scale globally. This can help us use agricultural fields and lawns to fight global warming as part of a larger plan. The research shows that the percentage of soil organic carbon is higher on average in natural paddock samples compared to landscaping lawn soil. The effects of the extra carbon in the soil can also be linked to less measurable changes in the soil, such as greater biodiversity of plant life and moisture content.

Purpose of the Study

The purpose of this study was to understand the variation of organic carbon in different soil samples at two different depths. The intent of testing at two different depths was to allow us to observe and learn where soil organic carbon is located within the soil, as well as compare the organic carbon content in engineered soil versus farm and natural soil areas. By researching this topic, we can use the information in future studies to understand how to increase carbon in the soil and better practices for our soil in the future.

Variables

- **Independent variables**
- Paddock 3, 2-3 inches
- Paddock 4, 2-3 inches
- Paddock 9, 2-3 inches
- Paddock 3, 6 inches
- Paddock 4, 6 inches
- Paddock 9, 6 inches
- Lawn sample from Fredon House
- Lawn sample from Siri House
- Lawn sample from Aarnaa House
- Lawn sample from School House
- **Measurable variables**
- Carbon content in Soil
- Moisture content in Soil

Experimental Method and Procedure

Weigh the metal tin and record the weight. Place the sieve over a bowl. Crumble and push the soil through the sieve to remove any rocks and roots.

Add sifted soil sample to the metal tin and record the weight. Subtract the tin weight from the total weight to get the fresh weight of the soil. Make sure the soil is spread out on the bottom of the tin.

Put the soil in an oven set to 60-80°C (140-175°F) for 4-6 hours to dry.

Remove it from the oven and allow soil to cool.

Reweigh soil + tin. Subtract the tin weight to get the dry weight of the soil.

Calculate the water content of the soil (wt. of fresh soil - wt. of dry soil)/(wt. of fresh soil x 100)

Reweigh the tin and record the weight. Put a large spoonful of the dry, sieved soil into the tin and weigh. Calculate the weight of the soil by subtracting the weight of the tin.

Light the camping stove or gas grill. Use the BBQ tongs to hold the tin directly over the flames. Slide the soil gently from side to side to introduce air into the sample. The tin should become red hot and the soil should smoke. Be careful!!

Once the soil is no longer smoking, keep heating it for a few more minutes. Then place it somewhere dry to cool. Silica gel inside a metal cookie tin is an ideal dry environment to cool the sample as it reduces the soil's ability to absorb atmospheric water.

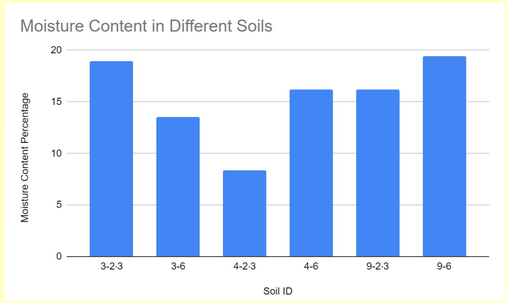
After the soil tin is totally cooled, weigh it on the scale. Subtract the tin weight from the total weight to find the weight of soil minerals.

Calculate the percentage of soil organic matter that has burnt away (weight of soil after burning minus weight of dry soil in tuna tin, divided by weight of dry soil in tuna tin x 100). This value is the "% Loss on Ignition" and is the percentage of the weight of dry soil that is organic matter.

Calculate the percentage of organic carbon in the soil by multiplying the % soil organic matter by 58%.

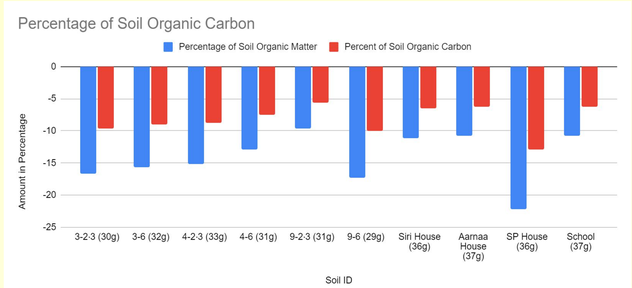
Results

Moisture Content in Soil



Description of Results:
Paddock 3, 2-3 inches; The moisture content was estimated to be roughly 18 percent.
Paddock 3, 6 inches; The moisture content was estimated to be roughly 13 percent.
Paddock 4, 2-3 inches; The moisture content was estimated to be roughly 8 percent.
Paddock 4, 6 inches; The moisture content was estimated to be roughly 16 percent.
Paddock 9, 2-3 inches; The moisture content was estimated to be roughly 16 percent.
Paddock 9, 6 inches; The moisture content was estimated to be roughly 19 percent.
We were unable to calculate the moisture content of the lawn samples due to a difference in testing procedure in which we air-dried the samples. This was an oversight on our part.

Percentage of Soil Organic Carbon



Description of Results:
Legend:
The red bar represents the amount of material that burned in the loss of ignition test or the amount of soil organic matter that burned. The blue bar represents 58 percent of that which is the rough estimation for the amount of soil organic carbon that makes up the soil organic matter.
Interpretation:
Paddock 3, the 2-3 inch depth sample and the 6 inch depth sample have roughly the same amount of soil organic carbon with the 3 inch sample having around 9.5 percent soil organic carbon and the 6 inch sample having 9 percent.
Paddock 4 displayed a larger difference with the 3 inch sample having 8.7 percent and the 6 inch sample having 7.4 percent organic carbon.
Paddock 9, the 3 inch sample had 5.6 percent while the 6 inch sample had 10 percent soil organic carbon. Three of the lawn samples (Siri's house, Aarnaa's house, and the School) had roughly 6 percent soil organic carbon. The South Plainfield house had 12.8 percent soil organic carbon.
Measurement Fidelity: All the paddock samples were maintained to weigh in the range of 29-32 grams(in tin) after drying the samples. The lawn samples had slightly more in each container with 36-37 grams in each tuna tin. This is due to the fact that lawns samples went through two steps - (1) Air dry lawn samples as is prior to sifting and (2) Dry sifted soil samples after measuring them into the tuna tins.
Total Weight in tuna tins for all samples: The paddock samples all added up to 60 grams before being dried and the lawn samples all added up to 60 grams after being dried.

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Conclusion

Monoculture Lawns: The three lawn samples that had the same amount of soil organic carbon were monoculture lawns. This means the samples were taken from areas that only had grass and the lawn was comprised entirely of grass. The final sample (south plainfield) which had much higher levels of soil organic carbon was taken from an area with significantly more "weeds" that had deeper roots and greater carbon sequestration abilities.
Paddocks: All of the paddock samples were taken from fields in which horses or cows graze on. The paddocks have a mixture of grass and legumes in natural soil. Considering the animals graze on the plant matter, the organic matter above ground was low. This leads me to believe that this process of grazing a biodiverse lawn is better for the soil, as all of the paddock samples had a greater amount of soil organic carbon on average. Adding to this, the soil looked healthier and evidence from research indicates that an increase in soil organic carbon helps plants grow and increases water retention.

LOI Test: We used a Solo Stove and had to add logs to keep the flame kindled. The first group of samples had less logs and we had to add more logs. This resulted in a larger flame and more combustion. As time went on and the flame got hotter faster, (ranging from 400 degrees celsius to 650 degrees celsius), and the samples were smoking quicker and had to be taken away from the stove faster. The rate of burning seems to have led to less residual soil organic carbon in the tin. For example, the final sample that we tested was the paddock 9 - 6" depth. There was loss of soil to wind/dust, which was reflected in the increased level of soil organic carbon in the tin.
In the future, I will improve the fidelity of protocols, including adding more precise step by step instructions for gathering and recording the data and samples. I will also perfect the number of logs needed for a consistent flame and temperature, so that the soil organic carbon results are more accurate.

Future Directions For Research

I will be analyzing more types of soil in the future and focusing more on the benefits of enhancing the carbon content in our soil while exploring ways to increase the carbon in our soil naturally.

References

1. The NJIN soil manual in which the procedure was pulled from.
2. The NSW DPI video on increasing soil organic carbon (NSW DPI Agriculture - YouTube)
3. A deeper look into the loss of ignition test by Dr. F Ball (https://bsssjournals.onlinelibrary.wiley.com/doi/10.1111/j.1365-2389.1964.tb00247.x)