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Personal Soil Report

Introduction:

There are many factors that go into a soil being able to produce vegetation. My personal soil sample was taken from a horse pasture. In order to grow enough grass to provide enough forage for horses, the soil needs to be able to absorb ample nutrients, hold water, and allow air flow. Testing the soil can provide information that can help improve the soil management in order to grow grass more effectively. In this report, I intend on examining the relationship of % clay (hydrometer) vs. CEC, which I hypothesize will be a positive relationship because clay particles are usually negative which would attract the cations and show an increase in CEC. In addition, clayey soils are able to hold lots of nutrients very tightly, which bigger particles like sand would not be able to do nearly as well because their colloids are much larger and fewer by volume versus clay. I will also examine the relationship between aggregate stability and active organic carbon. I think this relationship will be positive as well because typically a higher clay content makes soils more stable, and also has a higher active carbon content (USDA Forest Soil Carbon and Climate Change). Lastly, I will compare the pH of soil in water to pH of soil in KCl. I think this relationship will be positive because KCl attracts more Al^{3+} than water. This is important because the acidity of the soil determines plant growth.

Site description:

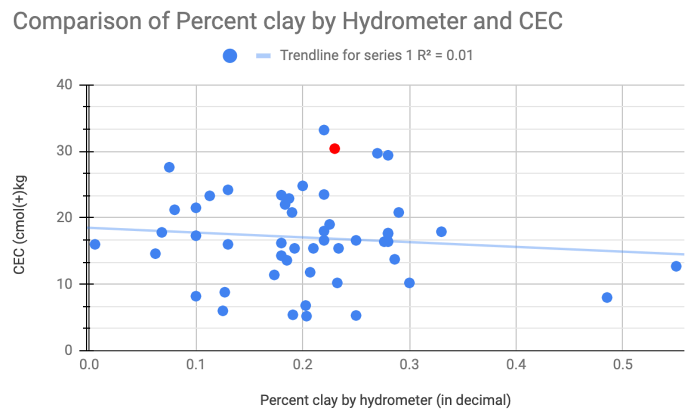
I chose to take a soil sample from the farm my horse lives at in Sandy Spring, Maryland. The sample was taken from one of the fields near a stream. There was little slope in the field and it is currently used as a pasture for horses and has horses living on it for most of the year. There is grass and other natural vegetation growing on the land. It is rested during the summer as needed for the grass to grow back after being grazed down and has been pasture land for the past few decades.

Methods:

This soil sample was taken from 10 different sites of the small field and taken from about 15 cm below the surface. The soil was collected, air dried, and ground up before any data collection began. Eleven different experiments were conducted in order to extract data about my individual soil and Web Soil Survey was used to reveal what kinds of soils exist on the farm. The database said that my soil should be a 6A Baile silt loam belonging to mesic Typic Endoaquolls order. Through the texture by feel experiment, it was determined that due to the length of ribbon created and texture of the soil, that it was 55% sand and 22% clay making the soil a sandy clay loam. I was not particularly good at making ribbons which is why this may have skewed my results and caused a higher sand percentage than is accurate. A more technical reading for the distribution of soil particle size was found by the Mechanical Analysis of Particle Size experiment, where my soil was placed into a Bouyoucos cylinder, filled with water and $NaPO_3$, agitated, then a hydrometer was used to measure how “thin” the suspension is. This yields a reading that was adjusted for temperature and $NaPO_3$ and eventually gave a mechanical reading that my soil was 55% sand, 22% silt, and 23% clay. Soil color was examined by wetting the soil then comparing it to the Munsell® Soil Color Chart. My soil was quite dark and determined that my soil was 7.5 YR 3/2 which was a brown color. The aggregate stability rating was obtained by dunking peds of my soil that were set aside before the soil was ground up at the beginning of the semester. The aggregates were dunked into water using a sieve, then compared to a key to determine what stability class the soil was. My soil had a stability class of 6, where “75-100% of the original soil remained on the sieve after 5 dipping cycles" (85, Weil). To determine how water would move through my soil, the water content of the soil at -5 kPa was measured. My soil was placed into a tube where filters were on either side of it. Water was then poured on top and I observed the rate at which the water percolated through the soil. After completing the necessary calculations, my soil had a value of 0.267 water content at -5 kPa. The total organic matter (experiment 17) was not conducted due to lab limitations. In order to see how tightly nutrients and minerals are held in the soil, a reading of the cation exchange capacity (CEC) was obtained where I found my soil to have an estimated CEC of 30.4 cmolc/kg. This was found by adding Gentian violet, which has a strong (+) charge to my soil, which would naturally have a (-) charge. Then the absorbance of the filtrate was obtained using a spectrophotometer and compared to the standard curve. In order to find out how much carbon was in my soil, $KMnO_4$ and $CaCl_2$ were mixed with soil and diluted with water, then shaken. The $CaCl_2$ causes the soil to flocculate and settle rapidly, and eventually we were able to get a reading of the active fraction of the carbon in the soil. This part of the soil requires lots of organic material from plants, the active carbon, aka the permanganate oxidizable carbon that I found was 1080 mg/kg. The pH of my soil was measured using two different methods, one with water, and one with salt (KCl). The soil was saturated with the according liquid, then a reading was obtained using a pH meter. The soil's pH using water was 7.17, the pH using KCl was 5.8. The final experiment conducted measured the plant available P. We collected leachate from a Mehlich1, soil, and charcoal solution which was then diluted with water and ascorbic acid was added. After taking the absorbance of the solution it was determined through calculations that my soil had 0 available phosphorus.

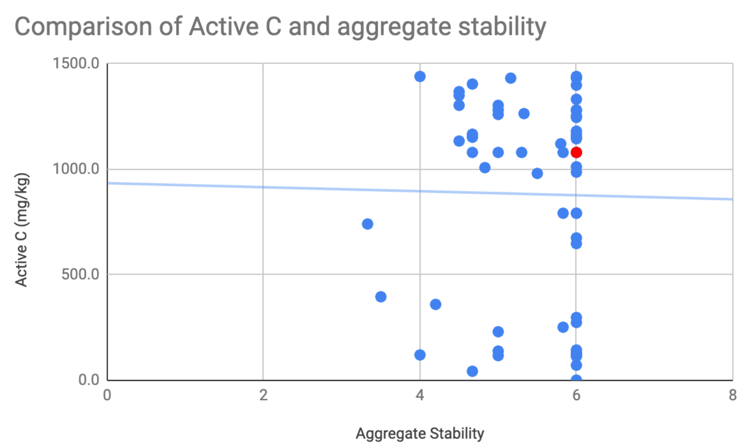
Results:

Figure 1:



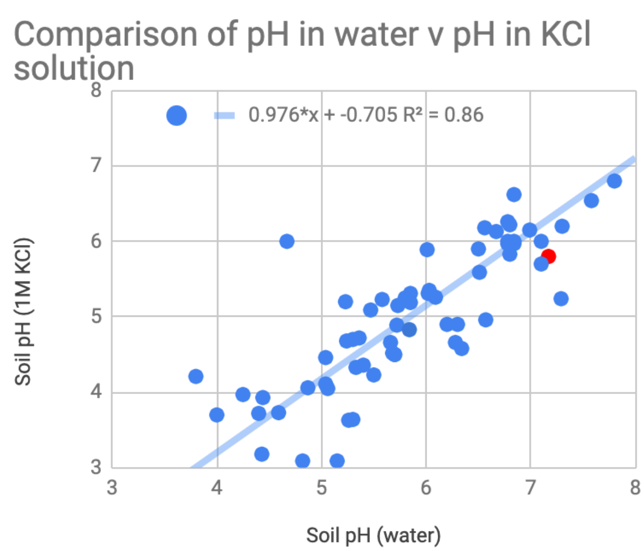
Negative relationship between clay content and CEC in soils tested. Personal soil marked in red.

Figure 2:



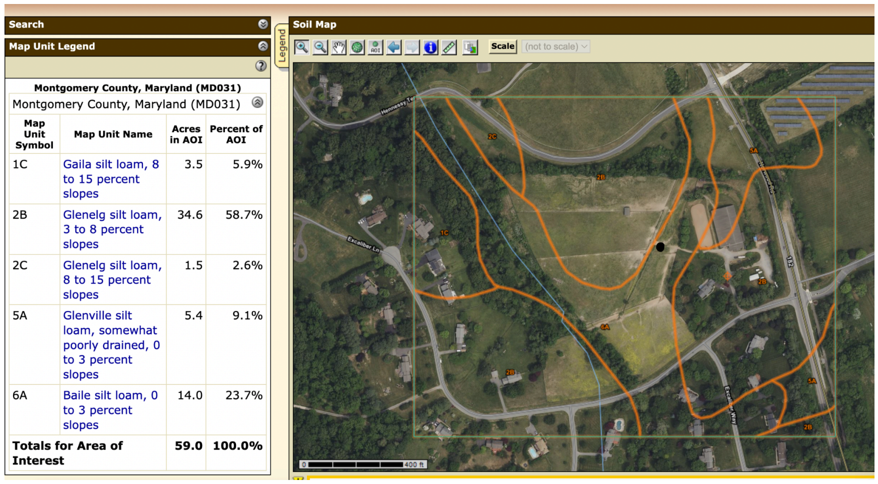
No relationship between aggregate stability and active carbon in soils tested. Personal soil marked in red.

Figure 3:



Positive relationship between soil pH in water and soil pH in KCl. Personal soil marked in red.

Figure 4:



Location of soil sample taken marked in black. Windsor Manor Stables, Sandy Spring, Maryland.

Table 1:

Property	Result
Textural class by feel	Sandy clay loam
Textural class by name (hydrometer)	Sandy clay loam
% clay by feel	22%
% sand by feel	55%
% silt (hydrometer)	22%
% sand (hydrometer)	55%
% clay (hydrometer)	23%
Color	7.5 YR 3/2
Agg. stability	6
Water content	0.267 cm3/cm3
pH water pH KCl	7.17 5.18
CEC	30.4 cmolc/kg

Active C	1080 mg/kg
Available phosphorus	0

Table G2 from appendix G in the lab book.

Discussion:

Soil clay particles are negatively charged which attract positively charged cations. The adsorbed cations are easily exchanged with other cations. This means soils with a high clay content often also have a high cation exchange capacity (CEC). It was expected for soils with a high clay percentage to also have a high CEC. This was mostly true as seen in Figure 1. While there is no 'perfect' CEC reading, sandy soils tend to have lower CEC's and are closer to zero, while high clay content soils can be as high as 50 cmol/kg. Soils with a CEC below 12 cmol/kg are generally considered poor at holding cation nutrients (Saha & Gaskin, 2016). Looking at figure 1, one can see that for the most part, the higher the clay percentage the higher the CEC was. The trendline, however, is negative. This could be due to errors in the experiment such as not reading the hydrometer correctly as well as not waiting long enough between reading to get an accurate representation of clay matter. The CEC of a soil is important because it shows how fertile the soil is through showing the soil's ability to absorb nutrients such as calcium, magnesium, and potassium for plants to use. My personal soil was an outlier. It was 23% clay with a CEC of 30.4 cmol/kg which was a lot higher than the rest of the soils. This is probably due to the fact that my soil has a high amount of organic matter due to being grazing land for horses and fertilized with their manure. This however means that the soil can hold more nutrients than some of the other soils which makes it better for plant growth.

Figure 2 shows the relationship between active carbon and soil stability. This relationship is important because if a soil has a high aggregate rating, it is harder for plants to grow due to less storage and movement for air and water. As seen in the figure, there was no clear trend in the data. This was unexpected. Most of the soils had a high stability rating which means they have a higher clay content. However, the active carbon in the soils did not appear to relate to the stability. Typically, the more stable a soil aggregate is, the higher clay content the soil has which means there is more carbon in the soil. However, these results show that soils with a stability rating of 6 still had a low active carbon content. My personal soil had a stability rating of 6 and an active carbon content of 1080 mg/kg. This was above the trendline, but this was expected due to the clay content in the soil. Having more carbon in the soil allows more plant growth. In addition, the stability of this soil makes it more ideal for infrastructure. Weak, sandy soils are less ideal for holding buildings than stronger clay soils.

Figure 3 shows the relationship between the soils pH in water and in KCl. As expected, the relationship was positive. While both KCl and water have a pH of 7, soils typically have a higher, or more basic, pH in water. The majority of soils tested had a higher pH in water than in KCl which was expected. This relationship is important to soil health because there is a sweet spot in pH that allows optimal plant growth. For grass, this is 6.5-7. If the pH is too low, lime can be added to raise the pH. If the pH is high, sulfur can be added to the soil to lower the pH. Adding compost can also fix soil pH naturally. My soil had a pH in water of 7.17 and a pH in KCl of 5.8. Soil pH affects the amount of nutrients and chemicals that are soluble in soil which means it affects the amount of nutrients available to natural vegetation. Some nutrients are available under more acidic conditions while others are more available under alkaline conditions (Chapter 9, Weil). Overall, this soil does a fairly good job of producing grass for horses to eat. However, this soil had no phosphorus (Table 1) which is a weakness. This land is not used for agriculture, but if it was, it would be important to add phosphorus through fertilizers to increase plant growth. Phosphorus is essential for plant nutrition and this soil does not naturally have it. For this soil's purpose of growing grass for horses, it is maybe not as essential and fertilizer options are more limited, however it is naturally fertilized with manure. It would be interesting to test phosphorus in the horse's manure and see how much is available to be absorbed into the soil for plants to use.

Sources:

Saha, U.K., and J.W. Gaskin. 2016. Cation exchange capacity and base saturation. University of Georgia ExtensionAvailable at https://extension.uga.edu/publications/detail.html?number=C1040&title=cation-exchange-capacity-and-base-saturation (verified 13 December 2022).

Forest Soil Carbon and Climate Change. Forest Soil Carbon and Climate Change | Climate Change Resource CenterAvailable at https://www.fs.usda.gov/ccrc/topics/forest-soil-carbon#:~:text=Soils%20with%20higher%20clay%20content,parent%20material%20and%20soil%20conditions. (verified 13 December 2022).