PEACE COUNTRY BEEF & FORAGE ASSOCIATION

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Forage Facts

Soil Organic Matter - Isn't Humus Something You Eat?

As stated in our April Forage Facts, a standard soil test reports soil organic matter (SOM) as a percent by soil weight. Essentially, a small sample of soil is weighed and then incinerated and weighed again. It is assumed that all the SOM has burned and that what remains is all mineral material. So, the difference in weight, as a percentage, is what is reported as %SOM.

Soil organic matter in Albertan soils typically ranges between 2-10%. Cultivated grey soils that were formerly under forest vegetation, as are many in the Peace, are typically around 3.5%. Soil organic matter is valued in agronomic systems due to its ability to release crop available nutrients to the soil over time as it degrades. It also improves soil structure and water infiltration. Moreover, SOM carries a negative charge and can therefore contribute to the cation exchange capacity (CEC) of soil, holding positively charged plant nutrients, such as calcium and magnesium, at the ready. Some questions arose around SOM at our most recent board meeting. What exactly is a soil test reporting on when it reports SOM as a percentage? Is an increase in SOM always an indicator of better soil health? This article will attempt to investigate SOM more thoroughly.

What's in a Soil Test?

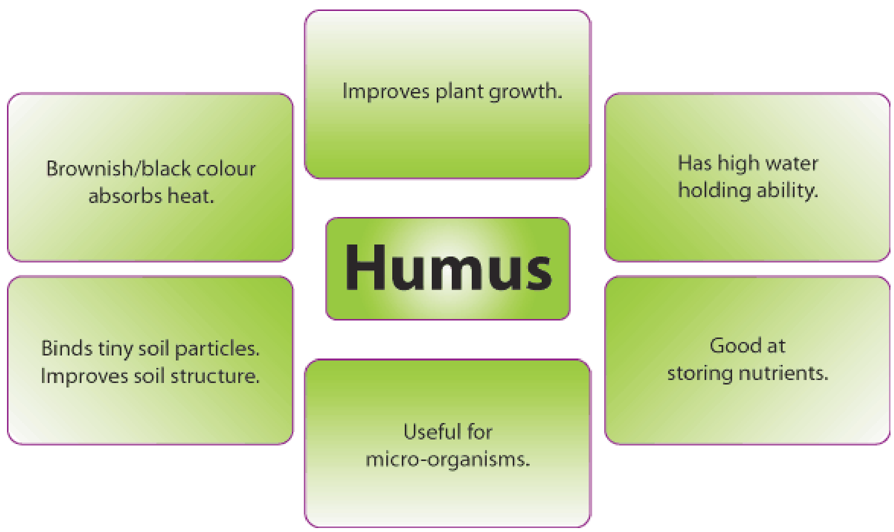
The SOM reported in a soil test lumps all plant, animal and microbial residues as one. The test does not differentiate according to how degraded the organic matter is. In other words, one gram of dead but completely intact plant matter counts equally to one gram of that magical substance known as soil humus. This fact is important because humus has a much higher capacity to contribute to the CEC of soils than other organic residues - WAY higher. Organic material with intact cell walls is unlikely to supply nutrients to soil microbes or plants whereas soil humus can. Yet, in a typical soil analysis, SOM is further used to calculate the cation exchange capacity, which is also contained in the soil report. For example, a typical formula for CEC used by many labs is as follows: CEC = 0.5 * (% clay in soil) + 2 * (% organic matter in soil). Two thoughts arise from this knowledge. Firstly, if a soil is high in plant and animal residue, but that residue is undegraded, the soil report will deliver a higher CEC than is likely accurate. In addition, if a soil is quite high in clay, but not in organic matter, CEC will also be unrealistically high as heavy clays without organic matter will have little porosity, poor drainage and impaired aerobic microbial functions.

So, unfortunately, a high %SOM from a standard soil test in no way indicates a soil has the same beneficial attributes associated with soils high in humus, such as the tremendous CEC, drought proofing and amazing soil tilth. While %SOM might indicate the amount of organic residue available that could develop into soil humus over time, what most land managers actually need to know is whether or not their management practices are facilitating the conversion of SOM into valuable soil humus, a process referred to as humification.

What's the Big Deal About Humus?

Humus differs from undegraded or oxidized organic residues, where intact cellular structures are still observable under microscope. It also differs from carbohydrates, fats, waxes, alkanes, peptides, amino acids, proteins, lipids and organic acids. While these organic residues are degraded, a distinct chemical formula can still be written for them. Humus is incredibly complex and variable and has no distinct chemical formula. Basically, it amounts to long chains of carbon attached to positively charged ions, (cations) and positively charged molecules. These are the soil nutrients humus is so famous for providing. Humus is both "highly substituted" and "labile" – the definitions of which are typically reserved for first year bio-chemistry students – but here goes: “Highly substituted” means that all sorts of different ions and molecules can stick to the carbon chain. “Labile” means they are constantly coming and going or even trading places. The point, however, is that they both stick and are mobile, making them consistently available for plant uptake while preventing them from leaching out.

Humus can be separated into four different types, according to how each type behaves when saturated with water of variable pH. These “humic substances” include humins, humic acid, fulvic acid and humates. Humins are not soluble in water at any pH. They are extremely resistant to complete decomposition and can persist for millennia. Humic acids are soluble above pH 2 but insoluble below pH 2. Fulvic acid is soluble in water of all pH conditions. Fulvic acids are a lot smaller and more chemically reactive than humic acids and have double the cation exchange capacity. Both humic acids and fulvic acids form salts with inorganic trace mineral elements such as iron, copper, zinc, calcium, manganese and magnesium. These salts are referred to as humates.



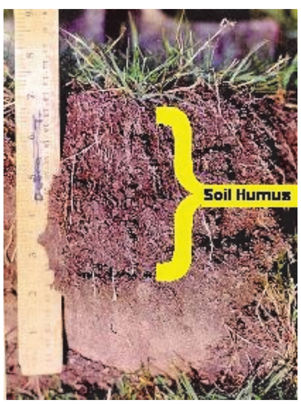
Complete humus is not just heavily decayed organic matter either. It includes clay particles and most importantly, microbial secretions. Bacteria and fungi both produce slimes that bind clays, humic substances and other soil components together, creating soil aggregates, or porous clumps that are rich in soil nutrients and soil life. The most important of these secretions is glomalin, which is considered a major component of soil humus. Glomalin is a super glue that coats the hyphae (tiny roots) of mycorrhizal fungi (a group of fungi who form symbiotic relationships with up to 95% of the world’s plant life). Soil aggregation is essential to good humus formation. The tiny air spaces, or micro-pores created by aggregation provide a home for all this microbial life and are also responsible for the drought proofing associated with high humus soils. These pores retain water molecules through capillary action, which can be released to plant life in times of need. In fact, the molecular structure of humus looks very much like a sponge under an electron microscope.

Microbial life plays other essential roles in the creation of humus and the subsequent provision of plant nutrition. Firstly, microbes are responsible for breaking down dead organic materials. Microbes release the mineral nutrients contained in organic bodies and degrade soil organic carbon (SOC) into those long carbon chains that are the building blocks of soil humus. Microbial nutrient cycling is particularly important in making the “life” nutrients of nitrogen, phosphorous and sulfur available. These nutrients carry a negative charge and are not held on the cation exchange. Unless they are retained in the bodies of some form of soil life, they are likely to leach out of the system entirely.

For example, organic nitrogen degrades first to ammonium (NH_4^+) and then to nitrate (NO_3^-) through a process known as mineralization. Bacteria named Nitrosomonas and Nitrobacter, do the work. These microbes also build nitrogen, phosphorous and sulfur into their body structures and when they die, other microbes, including mycorrhizal fungi, have an opportunity to steal some of these scarce leachable nutrients. Many of these microbes build these nutrients into their own body structures. Mycorrhizal fungi trade these nutrients for soil organic carbon exuded by their plant partners. Re-visit our February Forage Facts for a more thorough review of the soil food web.

Available soil nitrogen can also become tied up in microbial bodies if organic material with a very high carbon to nitrogen ratio (C:N) is incorporated into the soil. An example of a material with a high C:N would be wheat straw. The microbes become busy trying to break this difficult material down, and their metabolic processes require nitrogen in order to do so. So, for a time, nitrogen becomes unavailable. A way to resolve this issue is to make sure another material that is high in nitrogen is available for microbial decomposition at the same time. Manure is one such material – hence the increasing interest in chaff bunching and other forms of winter grazing on cropping landscapes.

What's a Grazier to Do?



Knowing all this, what are a grazier's options for effectively monitoring their soil humus? There are a few tactics that can be used with respect to soil testing. For starters, soil samples should always be taken from the true soil. The sampler should exclude any top layer of organic debris that is still recognizable as plant matter, as true humus will be located further down. This practice alone will improve the degree to which %SOM is indicative of soil humus. Some soil researchers have suggested soil tests should report soil organic carbon (SOC) instead of %SOM, as it is SOC that will actually degrade into the building blocks of humus. However, even SOC will only indicate the potential for humus to form, rather than actual content. Some commercial labs will actually measure the relative proportion of humins, humic acids, fulvic acids and humates in a soil. However, such tests can be costly, as a majority of labs do not do these tests regularly. The most reliable indicators of improved soil condition a manager should pay attention to include an increase in plant productivity and improved animal gain per acre. Such monitoring is totally free, if time-consuming.

Perhaps more importantly, a grazier should consider the degree to which their management practices promote microbial life, as it is the microbial processes described above that build soil humus. Microbes need moisture, heat and an adequate food source. Heat is provided by the sun. Moisture is provided by snowmelt and rain. A generous thatch of feed, pasture or crop residue can also help retain soil moisture as it slows down evaporative losses. This thatch is dually handy, as it also happens to be microbial food. However, like all healthy creatures, soil microbes need a balanced diet – in their case a C:N ratio of about 30:1. And, many plant residues tend to be a little heavy on the carbon side. Fortunately, most ranchers have a readily available source of high nitrogen materials that can kick-start the whole thing - manure and urine from grazing cattle. It goes even better if these microbe foods are all mixed up together and somehow trampled into the soil a bit. Manure and urine also just happen to supply additional water and heat, not to mention an inoculation of rumen and intestinal microbes that can help get the whole show started. PCBFA is currently investigating the C:N ratios of organic residues commonly found in the Peace Region and will sharing this information as it comes available - so stay tuned! And so, it turns out the old cowboy adage is true: If you haven't got cows, well, you haven't got… much.

Taylor Iwasiuk
2013 PCBFA Summer Technician

Hi Everyone! I'd like to introduce myself, Taylor Iwasiuk, as the new PCBFA summer student for 2013. I just completed my first year at Lakeland College in Vermillion, where I am enrolled in their Agribusiness diploma, majoring in Livestock production.

I grew up on a small purebred and commercial cow calf operation just east of High Prairie, where I am still actively involved in all aspects of the family farm, Classic Livestock.

Growing up I was very involved in the local 4-H club for 9 years. I still enjoy giving back to the 4-H community, from judging 4H shows and public speaking competitions, to putting on fitting and showmanship clinics. I am also a past member of both the Jr. Hereford and Angus associations. My many summers spent at provincial Jr. Livestock events and camps helped spur my desire to become more involved in the beef industry. I'm also currently involved in the stockman's and judging clubs at Lakeland.

I thoroughly enjoyed my first year at College and learned that I have a keen interest in livestock production and forages. I hope this summer I will be able to meet lots of producers in the Peace Region and gain more experience involving forages and livestock production.

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Monika Ross
New PCBFA ASB Project & Extension Coordinator!

Having grown up around the cattle business in the Peace Country, agriculture and the livestock industry have always been my passion. I have a Bachelor of Science in Agriculture, with a major in animal science from the University of Alberta. I began my career in the Peace Country with Champion Feeds and have gained a wealth of knowledge over the past year while working for Farm Credit Canada. I am very excited to join the Peace Country Beef and Forage Association and have an opportunity to work with Peace Country Cattle producers!

Monika will be joining the Peace Country Beef & Forage Association on July 23rd, working out of the High Prairie office. Be sure to stop by for a chat and get to know her!

Check out our new WEBSITE online! http://peacecountrybeef.ca/

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