POXC

UVM Soil Health Research and Extension Center

What is POXC?

Permanganate oxidizable carbon (POXC) is a chemically defined fraction of the soil organic pool that is oxidized by potassium permanganate. This metric represents energy available to microbial activity on a seasonal time scale. As POXC increases within the field, often so does plant productivity and soil biological processes such as nutrient cycling, and aggregation. POXC is an indicator of soil health that is responsive to management practices.

POXC vs. Organic Matter

Traditional testing for soil organic matter is performed through the loss-on-ignition method (LOI) that burns off all carbon from soil. The lost weight is mathematically converted to provide an estimate of percent organic matter. LOI includes all pools and does not always change or respond rapidly to management changes.

POXC represents a pool of carbon that includes slower-decomposing, complex molecules such as lignin, rather than sugars and starches that decompose quickly. Microbes decompose this pool on an intermediate timescale that lies somewhere between the readily degradable (labile) pools and pools more resistant to decomposition (passive).

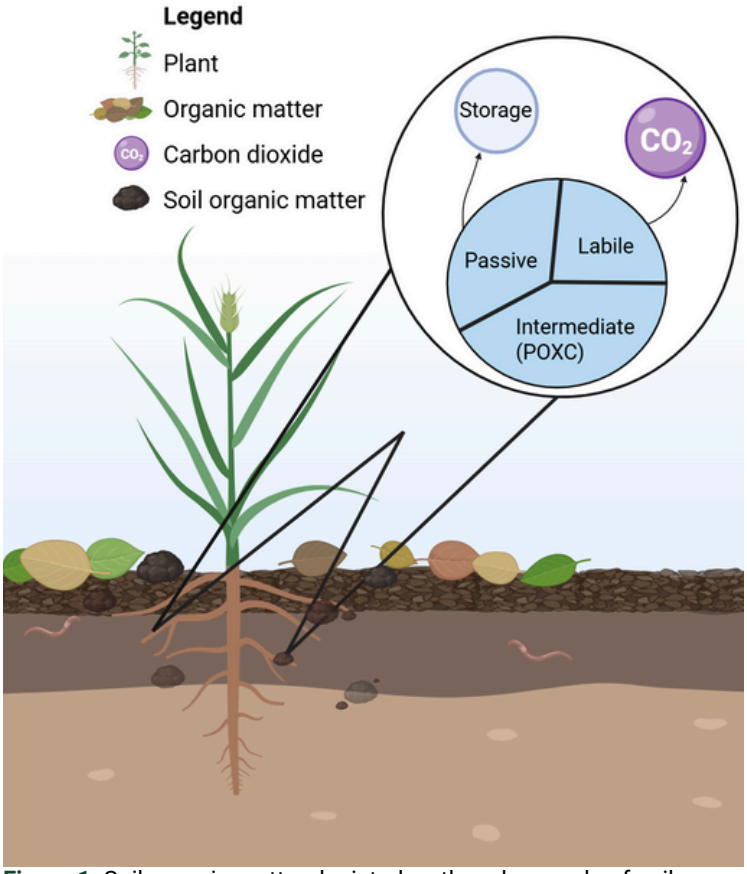

Figure 1: Soil organic matter depicted as three key pools of soil carbon: passive, intermediate, and labile.
Inspired by Sprunger and Martin (2023). Created with BioRender.com.

Benefits of POXC

POXC is an indicator of soil health, representing a pool of organic matter that supports microbial activity. Higher values of POXC reflect the growth and activity of beneficial soil organisms. These organisms:

- **Improve nutrient cycling** by providing a food source to support soil organisms responsible for the conversion of nutrients.
- **Improve aggregate stability** because organic matter serves as glue to hold soil particles together.

What affects POXC?

- **Climate:** Higher temperature and moist soil increase the decomposition rate of organic carbon, reducing POXC.
- **Soil texture:** Clay soils may have greater POXC levels because the clay can bind strongly to organic matter, protecting it from microbial degradation. Sand and silt are non-binding.
- **Soil pH:** POXC values tend to be higher in acidic soils than in basic soils due to the method's chemistry.

Because climate and soils are so important for determining POXC, it's best to compare your POXC values to similar fields and track them through time.

Basic protocol for testing POXC

- Air-dried soil, ground to < 2 mm, is placed in conical tubes. Water and a known amount of potassium permanganate ($KMnO_4$) are added.
- The samples are shaken and left to settle for a set time to allow the $KMnO_4$ to react with the carbon in the soil.
- An aliquot of the solution is diluted in water and loaded into a microplate to undergo a colorimetric analysis utilizing a spectrophotometer plate reader.
- Absorbance values are converted to active carbon units using a simple formula, and results are reported in mg of oxidized carbon per kg of soil (mg kg^{-1} or ppm).

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Understanding scoring

POXC values are reported in mg of oxidized carbon per kg of dry soil (mg kg^{-1} or ppm). Higher values are favorable and indicate a larger pool of available energy for soil biological activity.

Samples submitted to SHREC will be used to inform interpretation of POXC measurements based on management practices, geography, and soil type. SHREC aims to have a Vermont-specific scoring system (high, intermediate, and low values) in place as soon as an adequate quantity of representative soils have been processed.

How to increase POXC

Management practices that increase POXC include:

- **Add organic amendments** such as compost, manures, and plant residues.
- **Reduce tillage** to support accumulation of organic matter, aggregate stability, and microbial activity.
- **Diversify cropping systems** to vary root structures and residues by interseeding, intercropping, planting mixtures, or rotating crops.
- **Use cover crops,** which can add organic matter, provide food for the soil food web, and protect soil from erosion.
- **Use perennial cropping systems** to support the accumulation of organic matter by keeping it in the ground, often with deep and extensive root systems year-round, which reduces soil disturbance and adds residues.

Sources

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