Soil Quality Indicators

Particulate Organic Matter

Particulate organic matter (POM) fraction referred to in this document comprises all soil organic matter (SOM) particles less than 2 mm and greater than 0.053 mm in size (Cambardella and Elliot, 1992). POM is biologically and chemically active and is part of the labile (easily decomposable) pool of soil organic matter (SOM). Figure 1 shows tiny debris of POM (0.25 mm < POM size < 0.5 mm) at different stages of decomposition isolated from soil under no-till management. Studies have shown that POM accounts for few to large amounts of soil C (20% and more) in some soils of Eastern Canada and the USA depending upon agroecosystems and management practices (Table1).

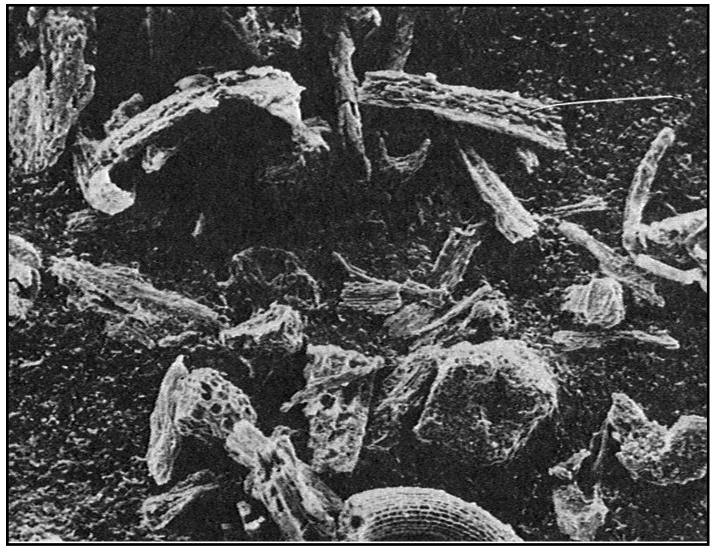

Figure 1. Particulate organic matter from no-till soil. From Cambardella and Elliot, 1992.

Factors Affecting

Inherent and dynamic soil properties and human activities that affect biomass production, accumulation, and/or decomposition will affect POM content in soils.

Inherent

Climactic conditions, such as rainfall and temperature, can affect the amount of plant biomass production and residues entering soil and thus POM accumulation in the soil. Soil types, especially soil texture, affect POM accumulation. For example, clay has a strong association with POM and serves as a physical barrier to microbial access, hence reducing microbial decomposition and increasing POM accumulation. Topography, especially elevation and slope, can create a gradient of POM distribution due to differences in temperature and vegetation types at different elevations and in erosion sensitivity on various slope classes.

Dynamic

The addition of plant residues or other organic amendments increase total organic carbon and its associated POM carbon (figs 2 and 3). Organic residues with a low C/N ratio (high nitrogen content) may decompose quickly and reduce the accumulation of POM. Soil disturbances such as destruction of aggregates by cultivation and alternating periods of wetting and drying expose organic matter to microbial decomposition and reduce POM content in soils. Stable soil aggregates promote POM buildup by protecting organic matter (OM) bound in and between aggregates from rapid microbial decomposition. However, adequate soil moisture and temperature, and aeration can accelerate the mineralization of SOM and its POM fraction.

Relationship to Soil Function

As perhaps the most easily decomposable fraction of non-living SOM after microbial biomass, POM fulfills many soil functions mediated by OM. It is a source of food/energy for microorganisms and soil animals as well as nutrients for plant growth. Particulate organic matter enhances aggregate stability, water infiltration and soil aeration; it increases cation exchange capacity and buffering pH. It also binds environmental pollutants such as heavy metals and pesticides. Particulate organic matter may play an important role in the suppression of soil borne diseases (e.g. damping off of cucumber) by compost. This may be explained by the fact that POM is an important source of food/energy in the compost for microorganisms responsible of disease suppression.

POM and Poor Soil Function

In poorly managed soils, the transport by erosion of sediments rich in POM into rivers and other water bodies can result in alteration of water quality and aquatic life. Build up and mineralization of those organic materials lead to the eutrophication of lakes and rivers. Incomplete mineralization of POM C in very poorly drained soils can lead to the formation of methane, which escapes into the atmosphere and contributes to ozone depletion.

Improving POM Levels

Management that affects SOM accumulation also affects POM content in soil (figs 2 and 3). More POM in the soil means that carbon and other nutrients are being stored in the intermediately available pool and are not subjected to losses (e.g., leaching) yet are available when needed. The following practices enhance POM levels:

- Tillage management (no-till, strip till, and ridge till)
- Crop rotation, cover crops, and cropping frequency (reduction in fallow frequency)
- Application of manure/compost and organic by-products
- Pasture and hay land management (e.g., rotational grazing and haying)

Measuring POM

There are several different laboratory methods to estimate POM and associated carbon. No reliable field methods exist yet. POM measurement in laboratory is time-consuming (1 to several days).

References:

Cambardella CA and Elliot ET. 1992. Particulate soil organic matter changes across a grassland cultivation sequence. Soil Sci Soc Am J 56:777-83.

Carter MR, Angers DA, Gregorich EG, and Bolinder MA. 2003. Characterizing organic matter retention for surface soils in eastern Canada using density and particle size fractions. Can J Soil Sci 83:11–23.

Fronning BE, Thelen KD, and Min D. 2008. Use of manure, compost, and cover crops to supplant crop residue carbon in corn stover removed cropping systems. Agron J 100:1703-10.

Table 1. Average C in whole soil, POM, percent POM-C (0-10 cm soil depth) from selected study sites in Eastern Canada. Adapted from Carter et al., 2002.

Site Name	Management	Whole Soil (C g/Soil kg)	POM (C g/Soil kg)	POM (%)
St. Rosalie	Cont. corn	30.2	8.2	22.5
La Pocatiere	Barley/clover	23.7	2.8	11.8
Normandie	Barley/clover	22.2	5.0	22.5
Nappan	Cont. grass	27.1	10.1	37.2
Benton	Potato rotation	20.3	12.1	12.0
Harrow	Corn/oats	21.5	2.7	12.5
St. Lambert	Cont. corn	22.3	3.9	17.5
Ottawa	Cont. corn	27.2	4.9	21.5
Chicott	Cont. corn	14.5	4.3	29.3
Harrington	Barley/soybean	21.2	2.8	10.8
Delhi	Corn/soybean/ grain/tobacco	7.6	1.4	18.4

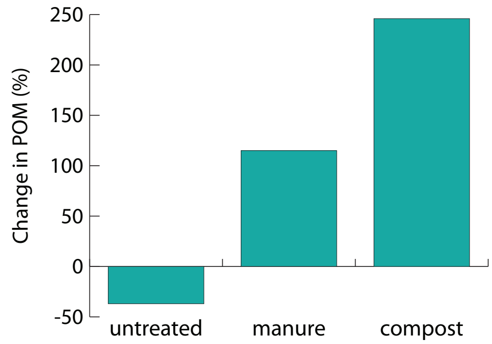

Figure 2. Effect of soil amendments on POM in crop soils. Adapted from Fronning et al., 2008.

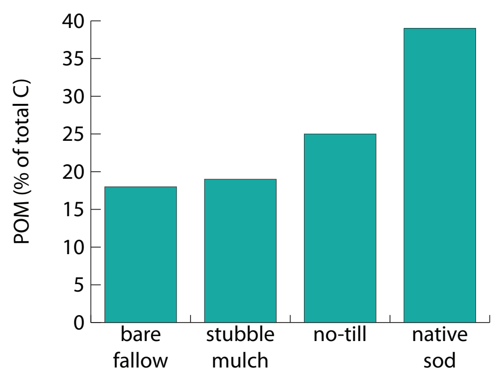

Figure 3. Effect of soil amendments on POM. Adapted from Cambardella and Elliot, 1992.