Effect of Organisms on Nutrient Availability

Soil Organic Matter

- Carbon
- Hydrogen
- Oxygen
- Phosphorus
- Nitrogen
- Sulfur

Soil Organic Matter

Biomass:
Living organisms

Detritus:
Identifiable
dead tissue

Humus:
unidentifiable
tissue

Humic

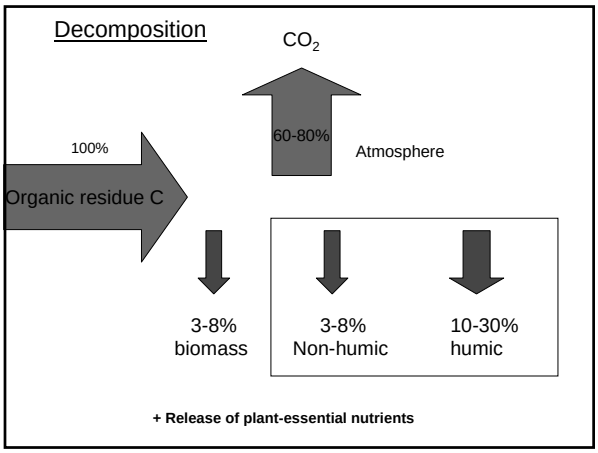
60 -80% SOM
Complex
Resistant, High C

Fulvic acid, humic acid, humin
(Undefined, high molecular wt.)

Nonhumic

20 -30% SOM
Less complex
Less resistant

Polysaccharides, proteins, acids
(defined, lower molec. Wt.)

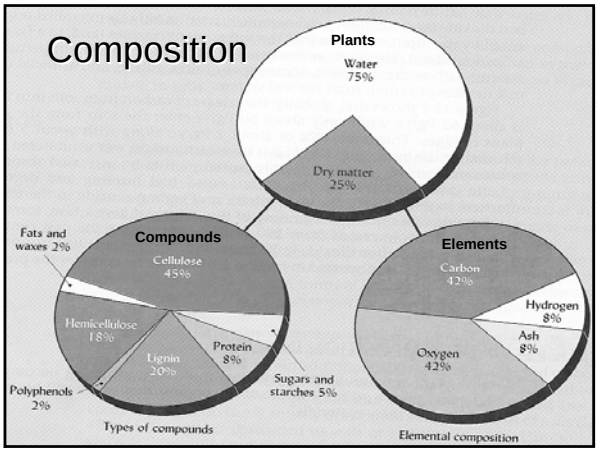


Factors in Decomposition

Factors in Decomposition

Composition of the organic material
Temperature/Climate
Water/Oxygen
Location
Size
Chemical Makeup

Composition



Composition Effect on Rate of Decomposition

Sugars/starches (5%)
Proteins (8%)
Hemicellulose (18%)
Cellulose (45%)
Fat & Waxes (2%)
Lignins and phenols (22%)

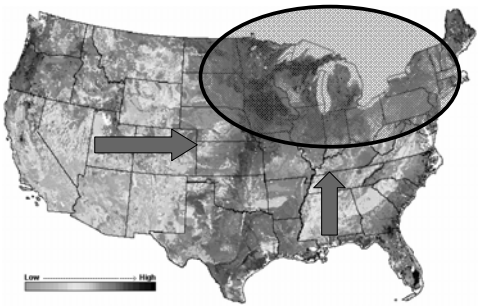
Rapid decomposition

↓

Slow decomposition

Effect of Climate (U.S.)

- Temperature: increases from N to S
  - Degradation increases, OM decreases, higher OM contents in soils from colder regions
- Moisture: increases from west to east
  - Biomass increases, OM increases
- High OM: Cooler temperatures, moist conditions
- Low OM: Hotter temperatures , dry conditions



A GENERAL RELATIONSHIP

Location and Size

Increased decomposition

- Surface placement (in rather than on)
- Particle size (small better than large)

Primary Chemical Factors

- Carbon to Nitrogen ratio (C:N)
- Near neutral pH

C/N Ratios

- The carbon content in plant dry matter is ~42%
- The carbon content in SOM ranges from 40 to 60%
- N content of plant residues ranges from <1 to >6%

Why C/N RATIO IS IMPORTANT

Soil microbes require C to build organic compounds in cells, and for energy.

Soil microbes need N to produce amino acids, proteins enzymes and DNA for cellular metabolism.

1. Microorganisms compete for soil N
2. C/N determines the rate of decay and the ultimate availability of nitrogen to soil and plants.

C/N ratio in Plants and Microbes

- Plant residues from 10:1 to 30:1 but can be as high as 600:1 (conifer sawdust)
- As plants matures N ↓, lignin and cellulose↑; C/N ↑
- C/N ratio is much lower in microbes (5:1 to 10:1)

C/N ratios of Organic Components

- Various C/N ratios
  - Soils 8/1 to 15/1
  - Microbes 5/1 to 10/1 (high N content)
  - Legumes 10/1 to 30/1 (alfalfa, soybeans)
  - Sawdust 400/1 to 600/1 (low N content)

Influence of C/N Ratio on Decomposition

- Soil microbes need C to build organic compounds and for energy, BUT
- Soil microbes need N to produce amino acids, enzymes and DNA
- Soil microbes have on average 8 parts C for every 1 part N in their bodies (C:N = 8:1)
- Soil microbes incorporate only about 1/3 of the C metabolized into their bodies; while 2/3 is respired as CO_2
- Therefore, soil microbes need 24:1 ratio in their "food"

24 carbons/ 1 N	2/3 C as CO_2	1/3 C in body
24 carbons	**16 carbons**	**8 carbons**

Decomposition and Nitrogen

Mineralization

The release of nitrogen from
The organic form to the inorganic form

Organic N (Organic matter) $\longrightarrow$ NH_4^+

Low C:N is desired for high rates of nitrogen mineralization

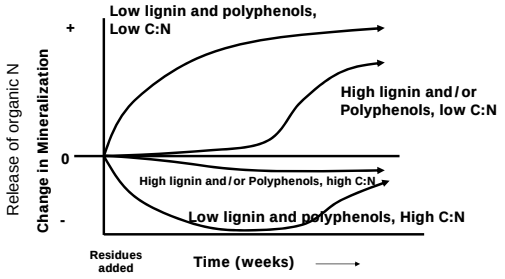
Decomposition and Nitrogen

Nitrification

The conversion of ammonium to nitrate

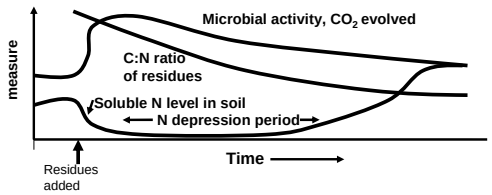
Mineralization Organic N (Organic matter) $\longrightarrow$ NH_4^+

Nitrification $NH_4^+ \longrightarrow NO_3^-$



For N mineralization (release) want low lignin, low polyphenol, and low C:N ratio.

Addition of residues with high C:N ratio

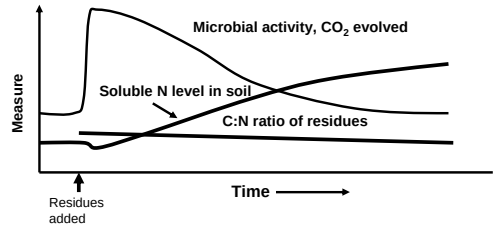


Addition of residue high in C:N ratio (> 25:1);

High microbial activity; CO_2 released

Microbes scavenge N from the soil, depressing the soil N

Addition of residue with low C:N



Addition of residue low in C:N ratio (< 25:1);

High microbial activity; CO_2 released

Getting N from the residual, increasing the soil N

Addition of residues with high C:N will increase microbial activity

However, there is insufficient N in the substrate for cellular growth and metabolism, Therefore, the organism will take N from soil solution depressing N in soil temporarily.

Addition of residues with low C:N also increases microbial activity

However, there is sufficient N in the substrate for cellular growth and metabolism, Therefore, the organism will release N to the soil increasing its levels.