**Effect of Organisms on Nutrient Availability**

Soil Organic Matter

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

<table>
<thead>
<tr>
<th>Biomass:</th>
<th>Detritus:</th>
<th>Humus:</th>
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<tbody>
<tr>
<td>Living organisms</td>
<td>Identifiable dead tissue</td>
<td>Unidentifiable tissue</td>
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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

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

Plants
Water 75%
Dry matter 25%

Compounds
Cellulose 45%
Hemicellulose 18%
Lignins 10%
Proteins 8%
Fats and waxes 2%

Types of compounds

Elements
Carbon 42%
Hydrogen 4%
Nitrogen 0.1%
Oxygen 43%

Biological 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

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 CO₂
- Therefore, soil microbes need 24:1 ratio in their “food”

  - 24 carbons / 1 N
  - 2/3 C as CO₂
  - 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 → NH₄⁺

(organic matter)

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

Nitrification

The conversion of ammonium to nitrate

Mineralization: Organic N → NH₄⁺

Nitrification: NH₄⁺ → NO₃⁻

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; CO₂ released
Microbes scavenge N from the soil, depressing the soil N
Addition of residue with low C:N ratio (
< 25:1);  
High microbial activity; CO₂ 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.