

2018

How the Carbon to Nitrogen Ratio Affects Soil Microorganisms

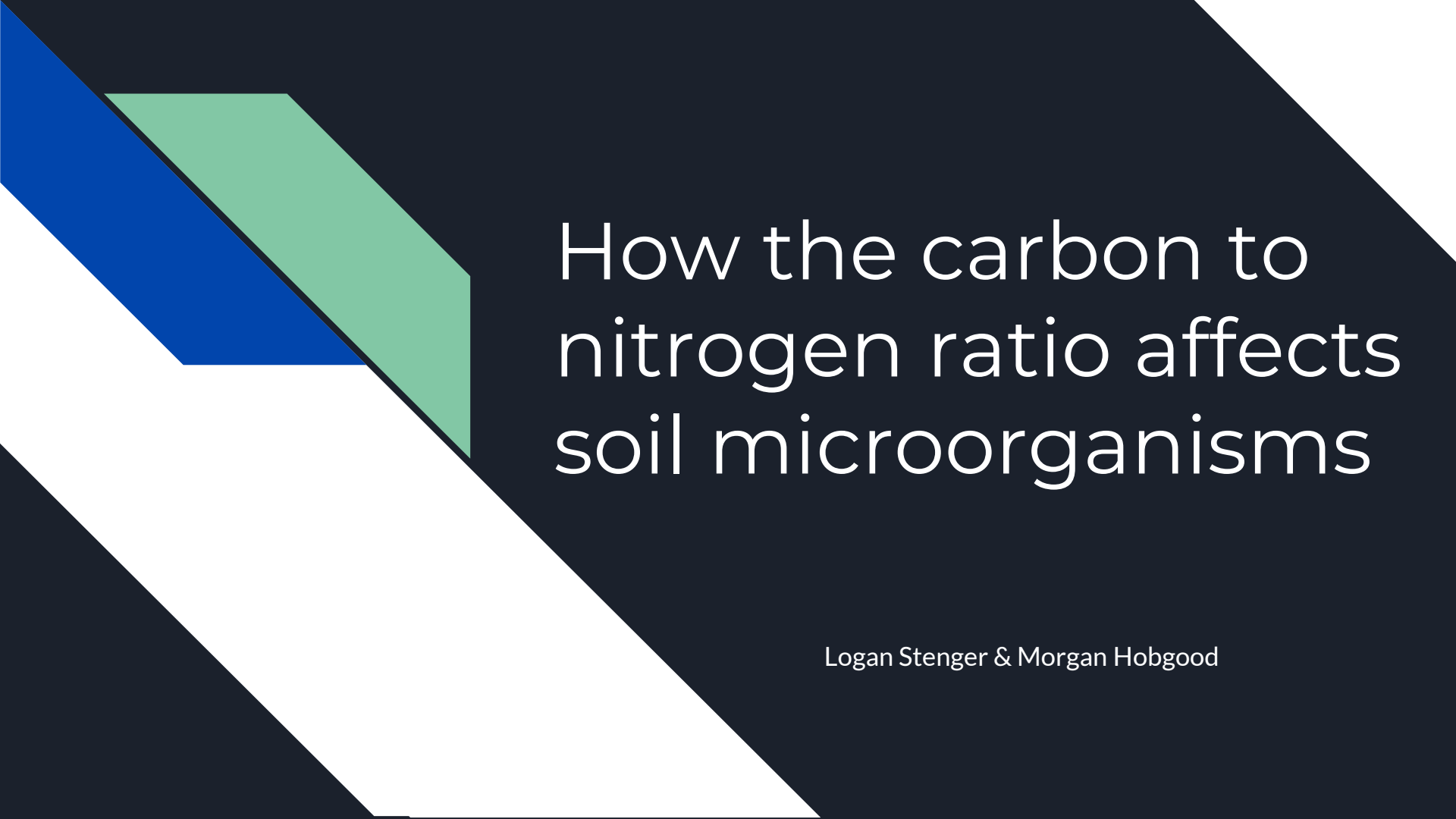
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Recommended Citation

Stenger, Logan M. and Hobgood, Morgan R., "How the Carbon to Nitrogen Ratio Affects Soil Microorganisms" (2018). *Natural Sciences Poster Sessions*. 150.
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How the carbon to nitrogen ratio affects soil microorganisms

Logan Stenger & Morgan Hobgood

Microorganisms

- Microorganisms:

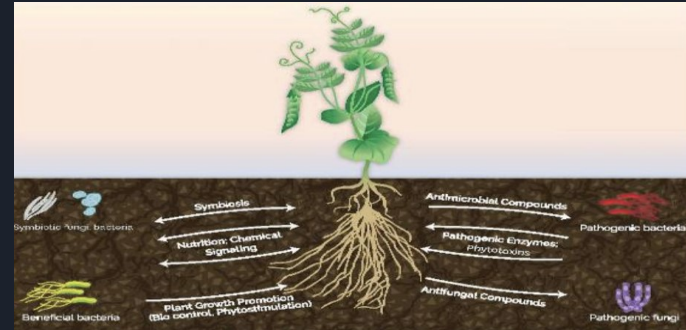
- Bacteria
- Actinomycetes
- Fungi
- Protozoa
- Nematodes

(Submerged Soils.)

- In order for them to become active they need important soil conditions:

- Right temperature (for every 18- degree rise, microbial activity increases 1.5- 3%)
- Right moisture
- Sunlight
- Oxygen (Less oxygen means less water holding capacity, which means less room for microbes to move.)

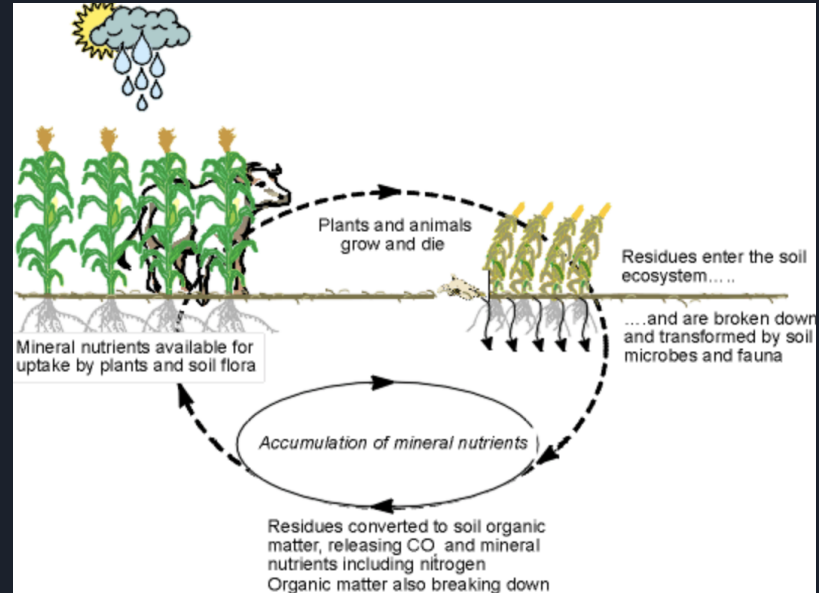
(Facts About Soil Microorganisms)



(Soil Microorganisms Contribute to Plant Nutrition and Root Health.)

Carbon to nitrogen ratio (C:N)

- C:N : a ratio of mass between carbon and nitrogen
 - Example: C:N of 14:1 means 14 units of carbon to every 1 unit of nitrogen.
- This ratio helps make the microbes build the soil up for plants to grow, because the microorganisms are able to recycle nutrients into the soil.
- Preferred ratio for microorganisms in the soil is 24:1



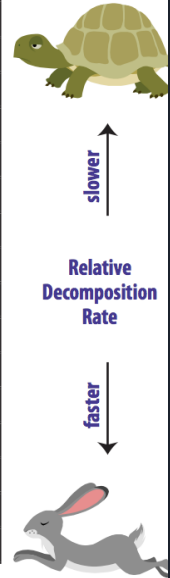
(Cycle of Soil Organic Matter and Nutrients)

Why does this ratio matter in soils?

- C:N ratio plays a role in microorganisms and crop residue decomposition.
- Plants with a high C:N ratio (rye straw, 82:1) decompose much slower than one that has a lower C:N ratio (young alfalfa hay 13:1).

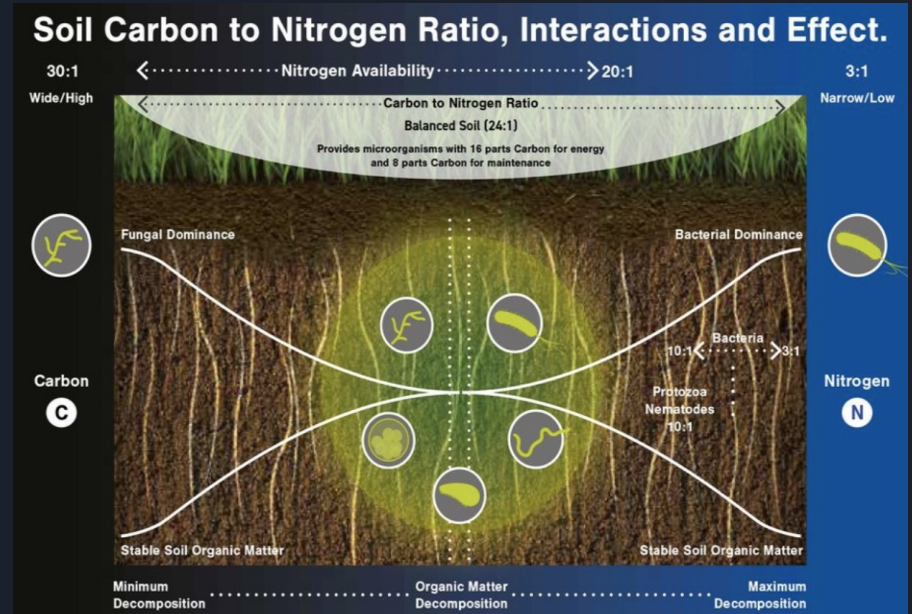
Table 1. Carbon to nitrogen ratios of crop residues and other organic materials

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	24:1
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



Microorganisms

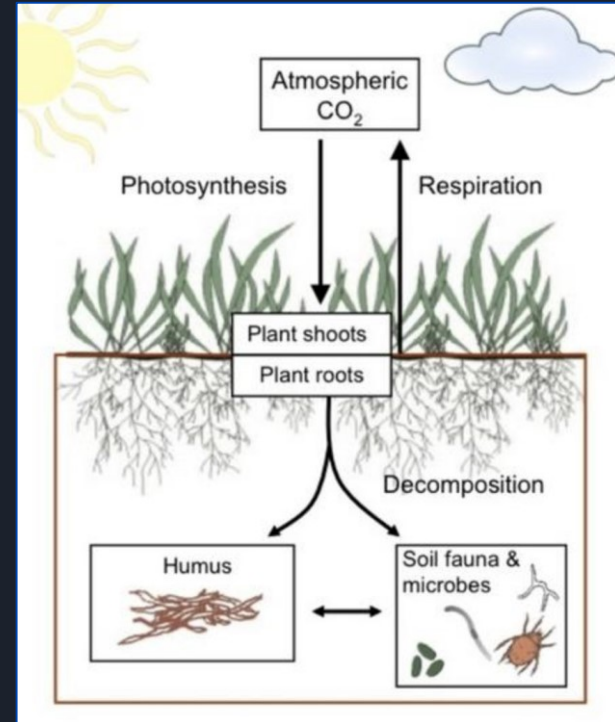
- Microorganisms play a huge role in the soil by providing nutrients, aeration, and decomposition.
- They are extremely dependent on C:N ratio. If there was no ratio, there would be no breaking down residue.
- They have a ratio of 8:1.



(“The Life in Your Soil.”)

Microorganisms cont.

- They feed off crop residue.
 - Crop residue: plants left over on top of the soil also known as soil organics matter, or humus.
- Microorganisms need the energy from the crop residue in order to survive and build the soil up.
- Most of the carbon the microorganisms consume go straight into their body, some is release as carbon dioxide in the process of respiration.



(5A: Soil, Carbon and Microbes)

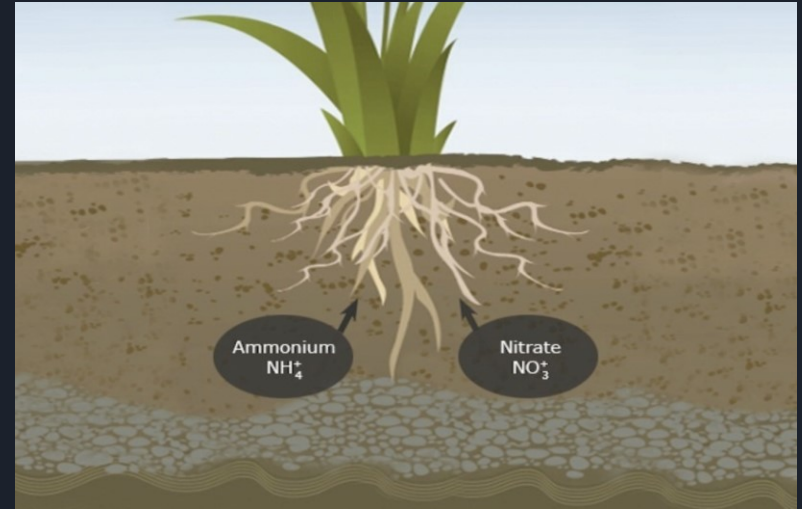


Microorganisms and decomposition

- Microorganisms activity is higher when the C:N ratio is lower because they do not have to work extra to find available nitrogen in the soil elsewhere.
- This is why a lower ratio decomposes much quicker, microbes prefer a lower ratio.
- Microbes are able to receive energy quicker.

Immobilization

- Immobilization begins when C:N ratio of crop residue is high 30:1 or higher. (Submerged Soils.)
- Microorganisms need more nitrogen than what is given to them to break the carbon down (Carbon to Nitrogen Ratios in Cropping Systems.)
- Microorganisms receive this excess nitrogen needed from the soil in forms of nitrate and ammonium (Submerged Soils.).



(The Nitrogen Cycle)



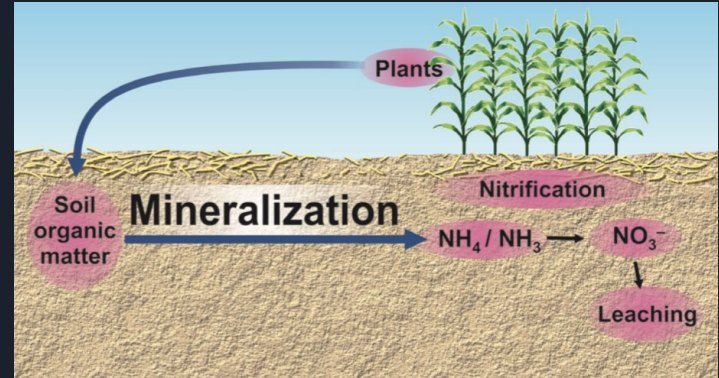
Immobilization cont.

- When the microorganisms take up the nitrate and ammonium, it allows for microbial activity to continue.
- They start breaking down the carbon in the crop residue.
- Microorganisms start taking the nitrogen from the soil so they can receive energy, but take too much that the soil does not have enough nitrogen for plant uptake.
- Until the microorganisms die and release their nitrogen the nitrogen will be immobilized in the soil.

(Submerged Soils.)

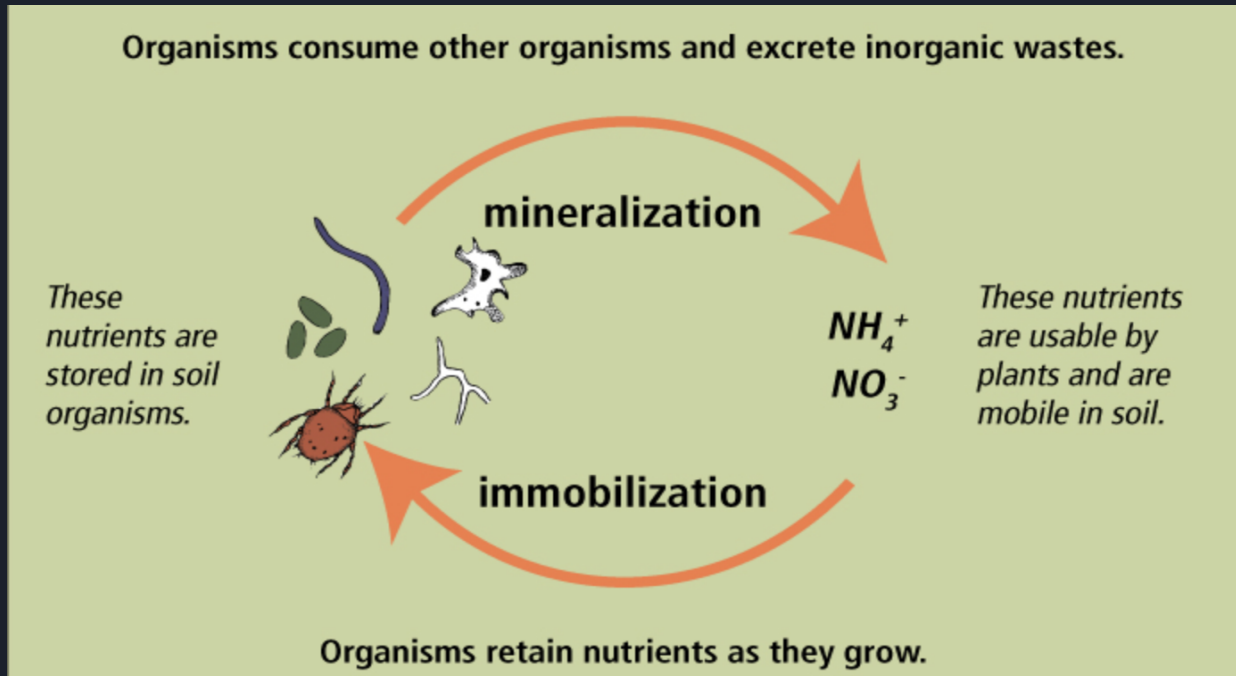
Mineralization

- When the C:N ratio is below the ideal range, the nitrogen is given by decomposition of microorganisms.
- When the microorganisms die and decompose in the soil they release nitrogen.
- A sufficient amount of inorganic nitrogen is available to the soil again for microorganisms to begin the process of decomposition again and for plant uptake while some leaches through the soil.



(What Happens to Nitrogen in the Soil?)

A better understanding of immobilization and mineralization



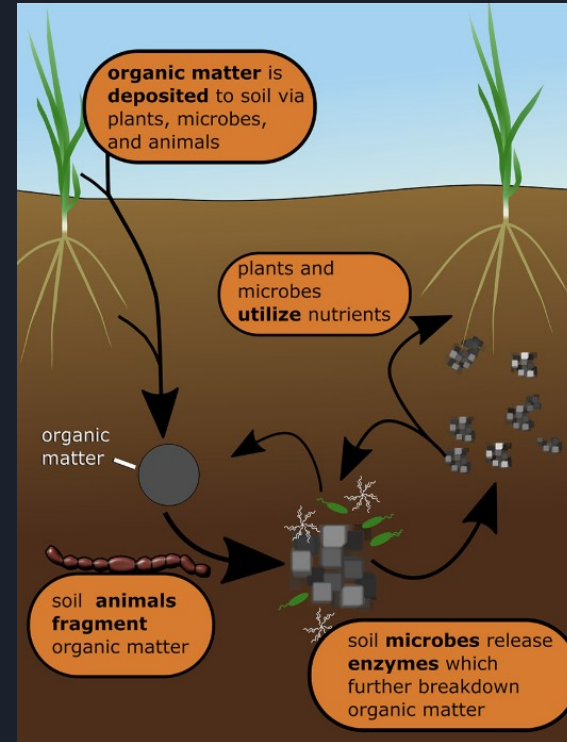


Microorganisms reproduce

- In order for the soil to stay healthy microbes need to reproduce from the ones that were lost in mineralization.
- As more crop residue is added depending on the C:N ratio, crop residue can be broken down, consumed, and recycled microbial population increases at a fast-steady pace when the microorganisms are able to keep up with the C:N ratio.
- This allows for a bigger microbial community, which leads to healthier soil.

Microorganism activity

- In order to boost microbial activity, crop residue needs to be present.
- When microbial activity is boosted they improve the soils nutrients.
- This allows the nutrients they make to become available to the plants. The cycle then continues.



Microorganisms activity is dependent on the C:N ratio

- If growers leave wheat straw (higher C:N) on top of the soil, the microorganisms are going to find energy elsewhere, and not release the nutrients needed for the soil.
- If a grower leaves legume hay (lower C:N), the microorganisms are going to break down that leftover residue, and potentially reproduce, and become more active in the soils.





Research Studies and conclusions:

- Canola, chickpea, wheat, and nil were used in an experiment to decide which decomposing at a faster rate.
- After putting each in the same soil and comparing, canola and chickpea were decomposing at a faster rate, because of the high contents of lignin which has an affect on C:N ratio.
- Cereal crops decompose quicker, and provide more organic matter.
- Decomposition of crop residue and C:N ratio and their effect on soil is very dependent on the residue type.
- Crop residue at 9 months was affected by high C:N ratio.
- This research showed to be very consistent with microbial activity enhancing by adding crop residue.



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