Immediate Release

March 9, 2020

James J. Hoorman
Hoorman Soil Health Services
Website: HoormanSoilHealth.com
Email: HoormanSoilHealthServices@gmail.com
Cell: 419-421-7255

Role of Soil Microbes

Soil microbes are abundant, making nutrients available to plants. There are more soil microbes in a teaspoon of soil than there are people on earth. Most soil microbes exist under starvation conditions and are dormant, especially in tilled soils. There are 1,000-2,000 times more microbes near active live roots than tilled soil, and each microbe is a soluble bag of plant available fertilizer. Active roots supply 25-45% of their total root carbohydrates to feed the microbes. The plants feed the soil microbes sugars and the microbes supply the plant with amino acids, soil nutrients, and water.

Bacteria, actinomycetes, and protozoa tolerate soil disturbance and dominate in tilled soils. Fungi and nematode populations tend to dominate no-till soils with live plants. Recent research shows that humus originates mainly from the dead bodies of microbes stacked up in the soil. Good soil is just a graveyard for dead microbes! Long-term no-tilled soils or soil with continuous live plants have significantly higher microbes, more active carbon (sugars), and more soil organic matter (SOM) than conventional tilled soils.

Bacteria are the first microbes to digest new organic plant and animal residues in the soil. Bacteria typically have low carbon and high nitrogen (C:N ratio) content in their cells (3:1 C:N ratio, 10- 30% N). Under the right conditions of heat, moisture, and a food source; they can reproduce very quickly (in 30 minutes). Bacteria are generally less efficient (20 to 30%) at preserving carbon or SOM. Soil oxygen levels often determine bacteria population levels. Most soil bacteria prefer well oxygenated soils (aerobic bacteria) and use the oxygen to decompose most carbon compounds. Examples of aerobic bacteria include the Aerobacter genus which is widely distributed in the soil and actinomycetes bacteria genus Streptomyces (antibiotics) which give soil its good “earthy” smell. Poor soil structure (compaction) creates anerobic (lack of oxygen) conditions for many disease organisms.

Fungi consume cellulose and lignin, which is slower to decompose. The lignin content in plant residues determines how fast SOM will decompose. Mycorrhizal fungi live in the soil on the surface of or within plant roots. Mycorrhizal fungi are 1/10 the size of a root hair and may

explore up to 20% of the soil volume compared to only 1% of the soil volume for a root hair. Fungi have a large surface area and transport mineral nutrients and water to feed the plants. Mycorrhizae fungi are a keystone microbe, vital to our ecosystem and human survival.

The fungus life cycle is more complex and longer than bacteria. Fungi are not as hardy as bacteria, requiring a more constant source of food. Fungi population levels tend to decline with conventional tillage, fallow soil, and high fertilizer usage. Fungi have a higher C:N ratio (10:1 C:N ratio, 10% nitrogen) but are much more efficient at converting carbon to SOM (40 to 55% efficient). With high C:N organic residues, bacteria and fungus may compete with corn for soil nitrogen (N). Generally, soil microbes efficiently utilize soil N to decompose organic residues, and plant roots have to compete for that N. Soil microbes like protozoa and nematodes consume the microbes, releasing N back to the plants.

Protozoa can reproduce in 6–8 hours while nematodes take from 3 days to 3 years (average of 30 days) to reproduce. After the protozoa and nematodes consume microbes (which are high in nitrogen), they release excess N in the form of ammonia. Ammonia (NH_4^+) can be converted to soil nitrates (NO_3^-) by bacteria. C:N ratios over 20 (high ligin, high carbon, low Nitrogen) tie up soil N while low C:N ratios release N. The C:N ratio of most soils is 10-12:1 indicating the release of N back to the plants.

Adding a living cover crop to a no-till field increases active SOM (root exudates in the form of sugars, amino acids, and proteins) for the soil microbes to consume, increasing microbial populations. Healthy microbial populations thrive in undisturbed soils with active live roots, decomposing organic residues, slowly releasing soluble soil nutrients. Cover crops prevent the soluble nutrients from being lost through soil erosion, leaching, volatilization, or denitrification. Healthy microbial populations provide nutrient dense food, higher crop yields and recycle soluble soil nutrients, so that we have clean water to drink. For more information google: Understanding Soil Microbes and Nutrient Recycling, SAG-16-10 on Ohioline.