Est. 2018
A Producer-Led Watershed Group
Farmers of the Sugar River
Promoting Conservation Practices

Microbiology Workshop

Look under the microscope at organisms in soil and compost

10AM- Noon
Aug. 13, 2024

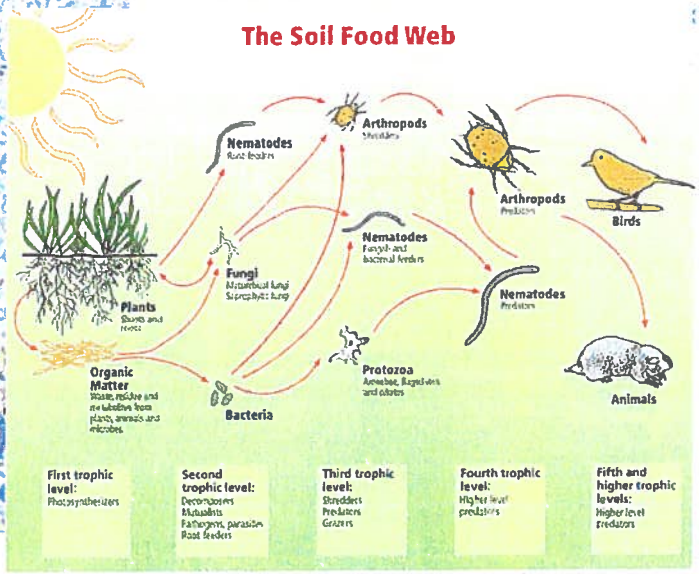
Bring a baggie of your own soil or compost to check for living organisms

Host: Bert Paris,
W3443 County W,
Belleville, WI

Special presenter:

Erik Harris

Soil Food Web Trained
Clear View Regenerative
Farms & Services



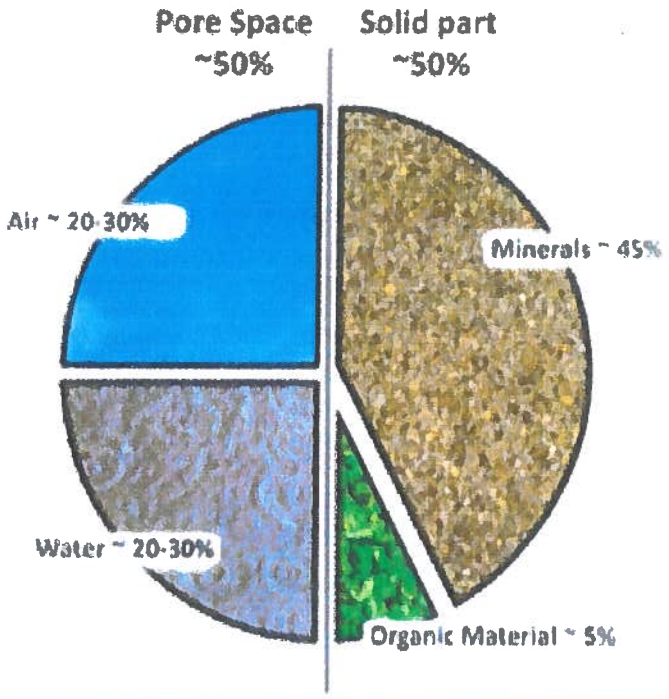
Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service

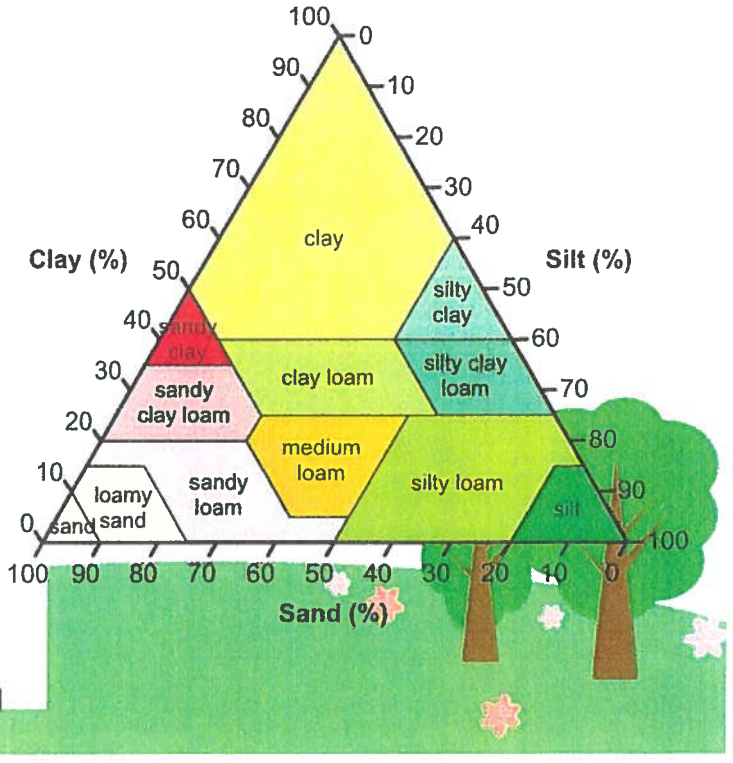
Contact Tonya Gratz 608-426-2218 for more information on this workshop

Funding for this was made possible, in part, by the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). The views expressed in written materials, publications, speakers, and moderators do not necessarily reflect the official policies of DATCP; nor does any mention of trade names, commercial practices, or organization imply endorsement by the State of Wisconsin.

Soil

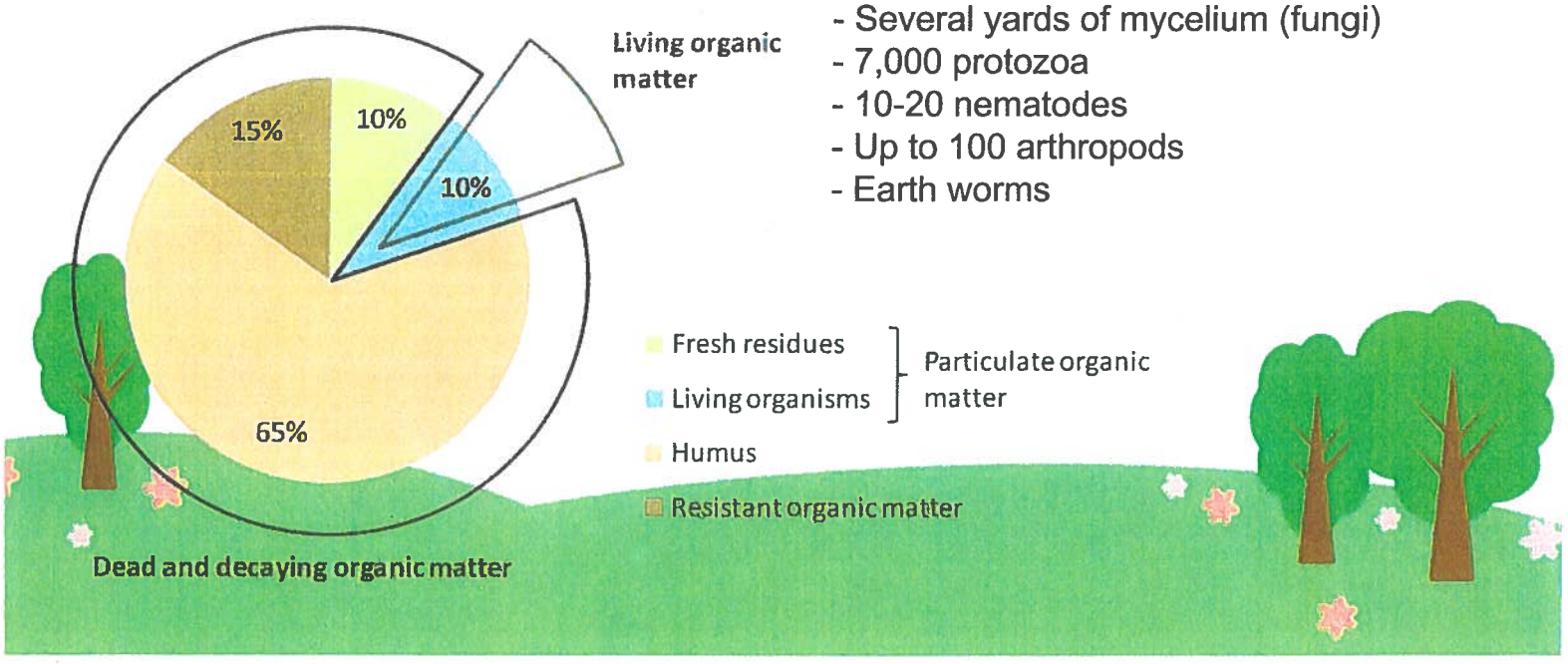
- Ideal Soils - Aerobic





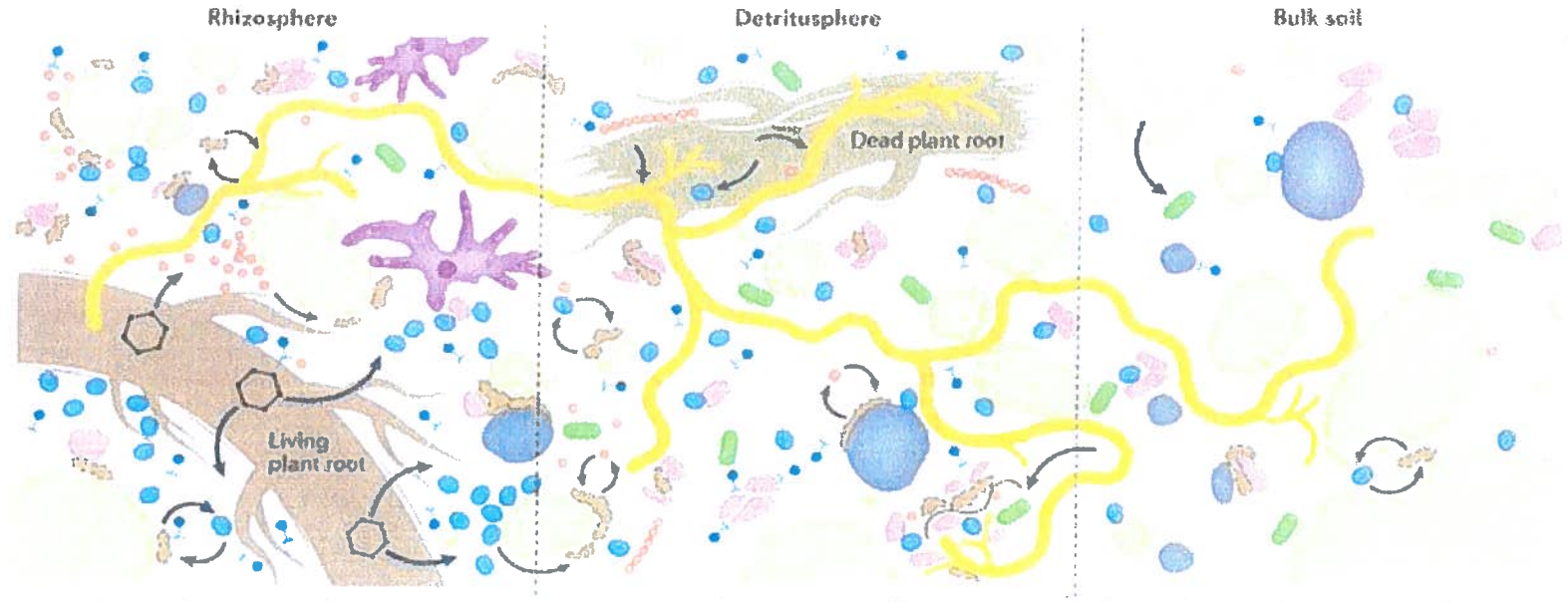
Soil

- What is in the 5% of Organic Matter?

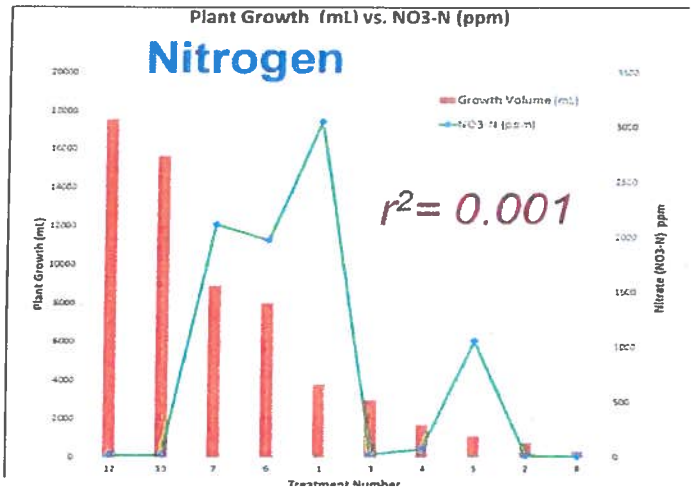


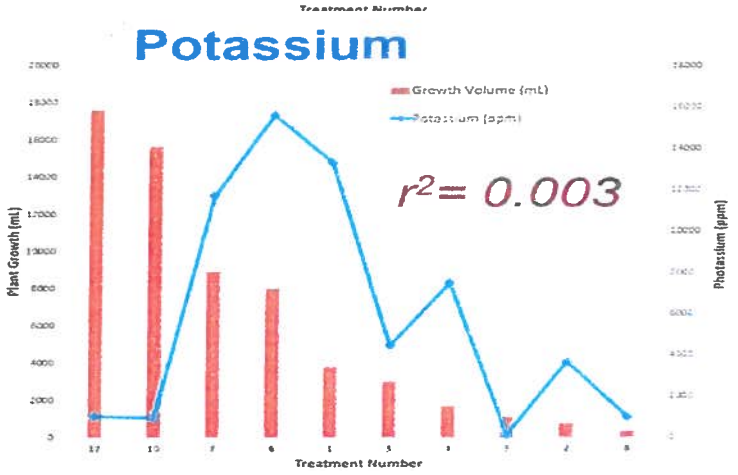
In one teaspoon of soil

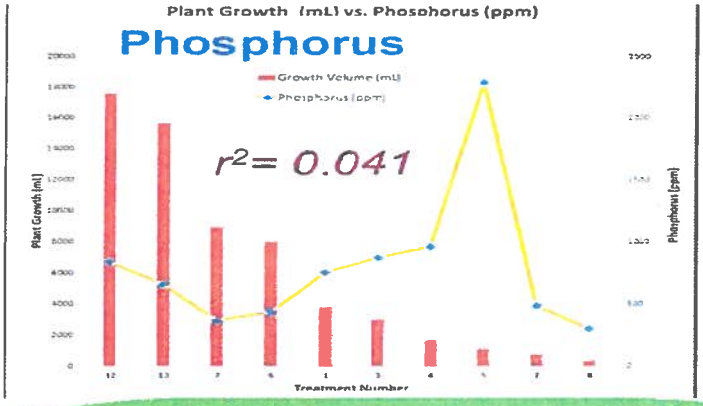
- 100 million to 1 billion bacteria
- Several yards of mycelium (fungi)
- 7,000 protozoa
- 10-20 nematodes
- Up to 100 arthropods
- Earth worms

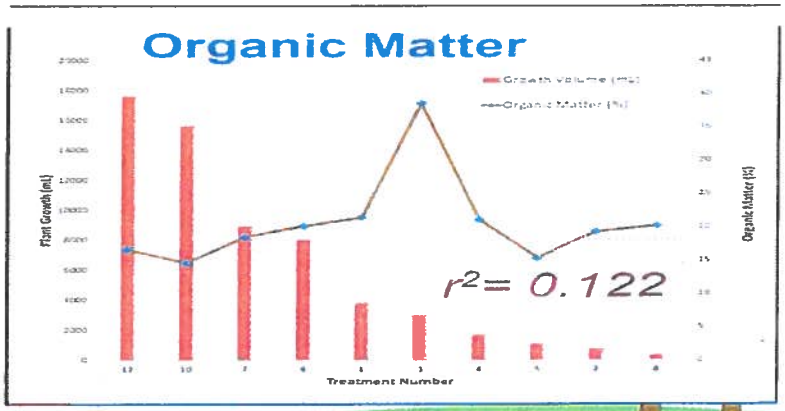

Rhizosphere
Detritusphere
Bulk soil
Dead plant root
Living plant root
• Organic matter inputs from living root (rhizodeposits)
• Higher microbial biomass and activity
• Lower microbial diversity
• Fast biomass turnover; high rates of organic matter flow
• Increased predation
• Organic matter inputs from dead litter
• Higher microbial biomass and activity
• Higher prevalence of saprotrophic fungi
• High rates of organic matter flow
• Lower microbial biomass and activity
• Higher microbial diversity
• Slower biomass turnover and rates of organic matter flow
Bacteria
Rhizodeposit
Protist
Mineral-associated organic matter
Clay particles
Aggregate
Viral particle
Fungal hyphae
Microbial necromass
Organic matter flow
Primary mineral grain

Nutrients and Plant Growth

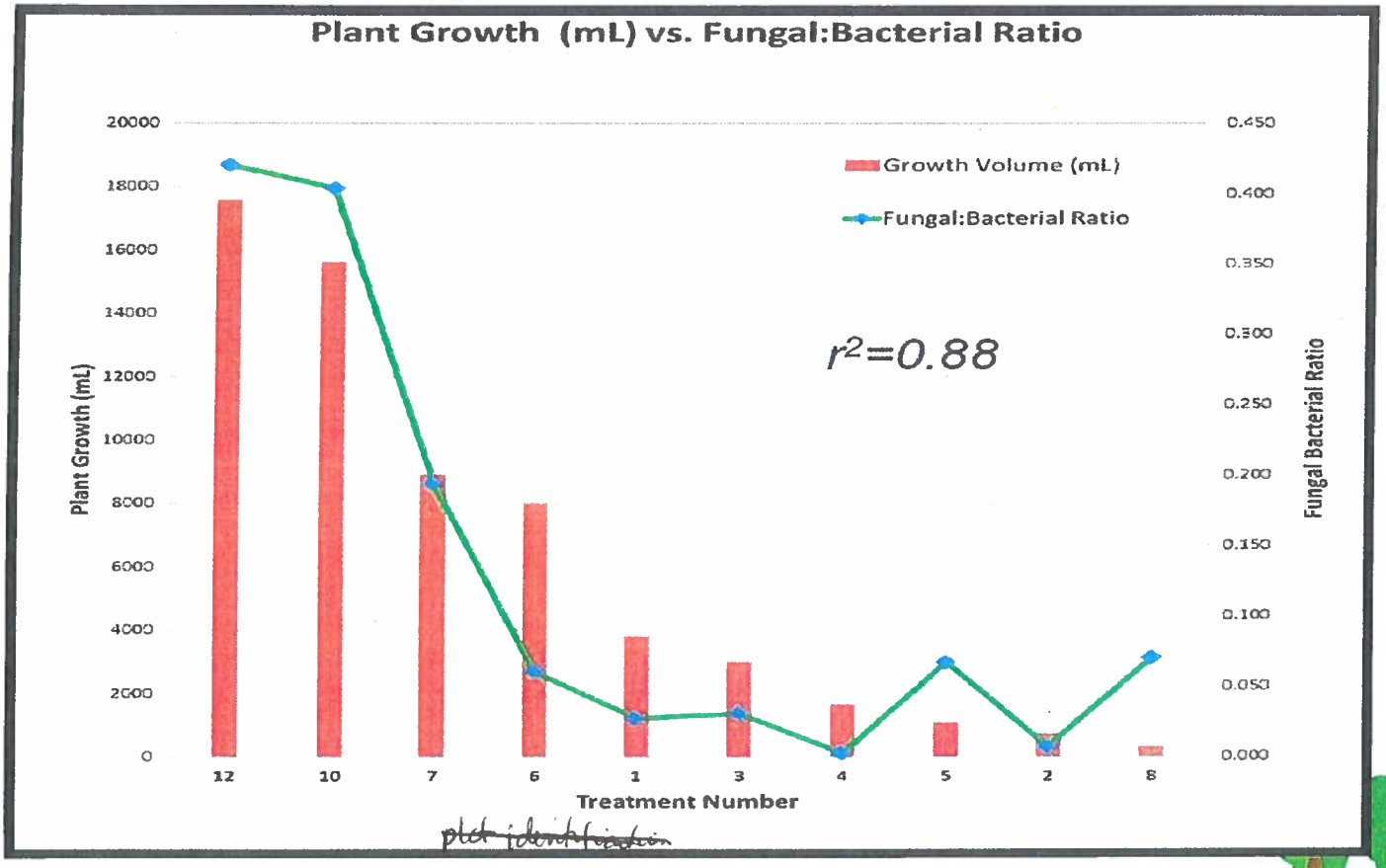








Biology and Plant Growth



Soil biological succession causes plant succession

Bacteria ...A few Fungi.....Balanced .....More Fungi..... Fungi

Bacteria:	**10 µg**	**100 µg**	**500**	**600 µg**	**500 µg**	**700 µg**
Fungi:	**0 µg**	**10 µg**	**250**	**600 µg**	**800 µg**	**7000 µg**
Fungi: Bacteria Ratio	10000: 1	10: 1	2: 1	1: 1	1: 2	1: 10

Average Levels of Compost Nutrients

This page gives average levels of nutrients as found by Soil Control Lab in its analyses of more than 1,600 Compost sample from the southwestern U.S.

The values presented in the tables below are averages, and actual nutrient levels will vary.

Compost Attribute Values

Attribute	Value	Unit
Organic Matter dw*	42.32	percent
Total Carbon dw	22.19	percent
Carbon/Nitrogen	16.8	ratio
pH	7.6	
Electrical Conductivity (EC5) dw**	7	(w/w) mmhos/cm
Sodium (Na) dw	0.28	percent
Carbonates ($CaCO_3$) dw	45	lb/ton

Primary Nutrients

Nutrient	Value	Unit
Nitrogen dw	1.53	percent
Ammonium (NH4-N) dw	741.9	mg/kg
Nitrate (NO3-N) dw	291	mg/kg
Potassium (K) dw	1.13	percent
Potassium (as K2O) dw	1.36	percent
Phosphorus (P) dw	5900	
Phosphorus (as P2O5) dw	1.34	percent

Secondary Nutrients

Nutrient	Value	Unit
Calcium (Ca) dw	3.28	percent

Nutrient	Value	
Magnesium (Mg) dw	0.63	
Sulfate (SO4) dw	4384	mg/kg

Micronutrients

Nutrient	Value	Unit
Copper (Cu) dw	117	mg/kg
Zinc (Zn) dw	248	mg/kg
Iron (Fe) dw	15321	mg/kg
Manganese (Mn) dw	291	mg/kg
Boron (B) dw	51.5	mg/kg
Chlorine (Cl) dw	3137	mg/kg
Molybdenum (Mo) dw	4	mg/kg

*dw=dry weight

**EC5 is the electrical conductivity of a slurry composed of one part compost to five parts water by weight. Compost EC5 diers from the typical electrical conductivity measurement of soil (ECe) in that it is gravimetric as opposed to volumetric, and, in most cases, requires more water to make the 1:5 slurry than what is required to make the ECe saturation paste. Theseerences make it such that the EC5 will almost always be lower than the ECe, and, diicult, if not impossible, to correlate the two measures."

foundation for fungal growth

Benefits of Humic Substances

The Humic Products Trade Association[5] has conducted a review of the scientific literature and has approved three primary label claims for agricultural application of humic substances:

- Improved root mass and growth
- Enhanced nutrient availability and uptake
- Higher crop yield and quality

How are these benefits accomplished? We'll discuss a few of these mechanisms here:

- The presence of carbon-containing humic substances in soil results in electrical processes that cause very small soil particles to attract each other to create a crumb structure in the topsoil, which has open spaces that allow gaseous exchange with the atmosphere and better water infiltration. This resulting soil structure also increases the water-holding capacity of soil, protecting plants during times of drought.
- Energy stored within the carbon bonds of humic substances represents an excellent food source for soil microorganisms that perform a wide range of functions that contribute to soil and plant health—everything from solubilization of minerals that are bound up in the soil to releasing antibiotics that protect plants from pests.
- Humic substances have an insulating property that helps to stabilize soil temperatures and slow the rate of water evaporation, which protects plants during change periods of heat and cold.
- Humic substances can also stabilize or inactivate certain soil enzymes released by plant pathogens, rendering them less able to damage plants.
- Further, humic substances can buffer soil pH, making the soil less alkaline or less acidic. This results in helping trace elements that may have been bound up in the soil due to acidic or alkaline conditions to now become available to the plants as nutrients.
- Additional soil benefits are that toxins left in the soil from pesticides can be degraded or inactivated by humic acids, and the addition of humic substances to soils containing excessive salt can help reduce the salt concentration, making the soil more suitable for plant growth.
- Humic substances help regulate the retention and release of plant nutrients. The higher cation exchange capacity (CEC) that occurs when humic substances are present in soil increases a soil's ability to retain positively charged plant nutrients (e.g., NH_4^+, Mg^{2+}, Ca^{2+}, and Na^+) and reduces the potential for leaching. Soil CEC also influences the application rates of lime and herbicides required for maximum effectiveness.[6]
- When adequate levels of humic substances are present in soil, plants have an enhanced ability to take up nitrogen, phosphorus, and potassium—reducing the amounts of N-P-K fertilizers required.
- Application of humic or fulvic acids to seeds speeds up seed germination, enhances root development, and activates seedling growing points.

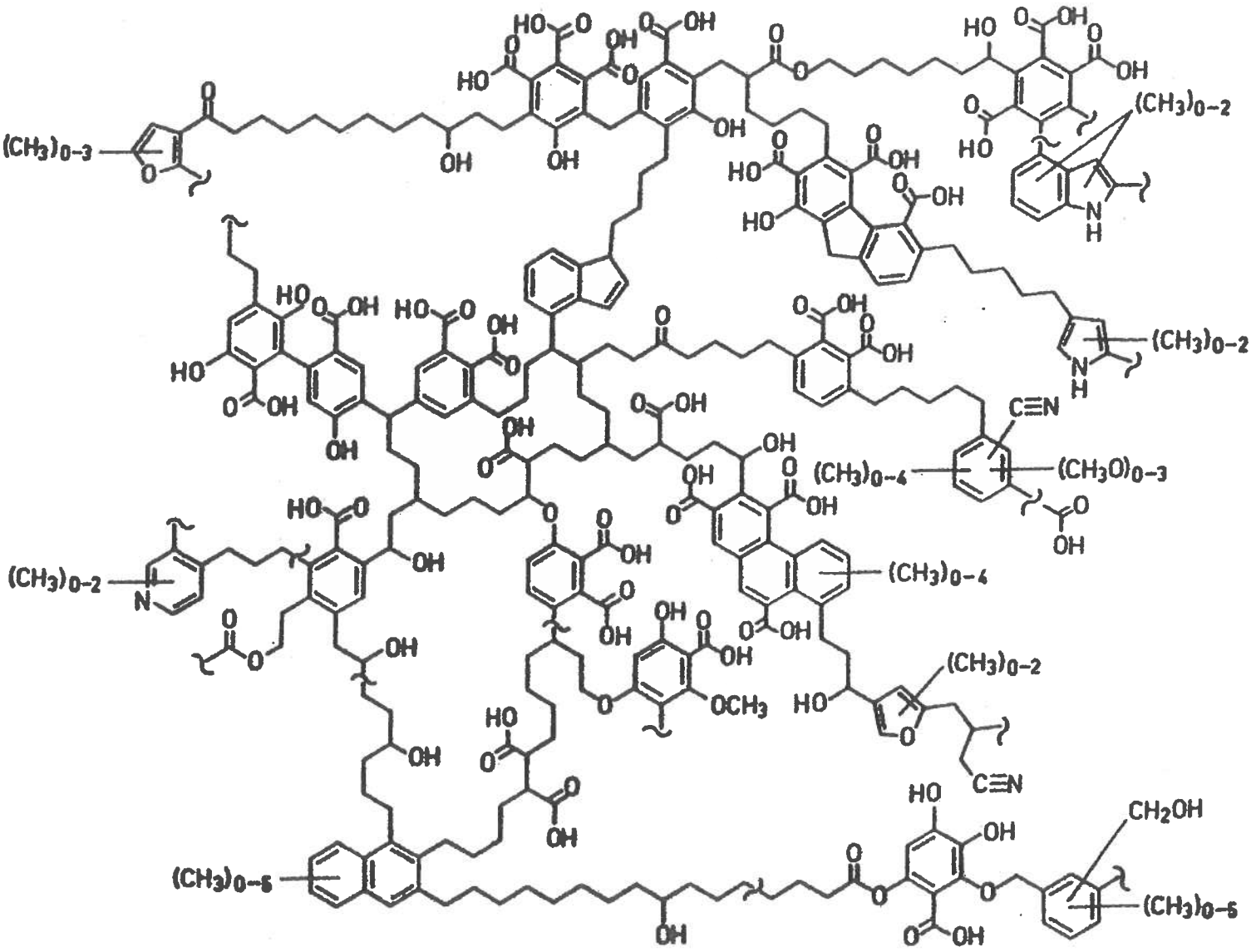
- Humic substances influence plant growth hormones and provide free radicals to plant cells, which have positive effects on seed germination, root initiation, and plant growth in general.
- Humic and fulvic acids, while not fertilizers themselves, are excellent fertilizer carriers and activators. Foliar fertilizers containing humic or fulvic acids have been demonstrated to be from 100% to 500% more effective than similar fertilizers applied to the soil.[2] Applications can be timed to activate vegetative growth, flowering, fruit set, or filling and ripening of fruits.

References

1. Jackson WA. (1993). *Humic, Fulvic, and Microbial Balance: Organic Soil Conditioning*. Jackson Research Center, Evergreen, Colorado.
2. Petit RE. (2002). *Organic Matter, Humus, Humate, Humic Acid, Fulvic Acid and Humin: Their Importance in Soil Fertility and Plant Health*, p. 1–24. Texas: A & M University. Available at http://www.humates.com/pdf/ORGANICMATTERPettit.pdf.
3. International Humic Substances Society. Available at http://www.humicsubstances.org/.
4. Stevenson FJ. (1982). *Humus Chemistry Genesis, Composition, Reactions.* Willey Interscience, New York.
5. Humic Products Trade Association. Available at http://www.humictrade.org/.
6. Overstreet LF, DeLong-Hughes J. (2009). *Tillage: The Importance of Soil Organic Matter in Cropping Systems of the Northern Great Plains*. University of Minnesota Extension. Available at http://www.extension.umn.edu/agriculture/tillage/importance-of-soil-organic-matter/.
7. Lal R. (2002). Soil carbon dynamics in cropland and rangeland. *Environmental Pollution*, 116:353–362.
8. Seyedbagheri MM. (2015). *30 years of Research Documents the Influence of Humic Substances on Soil Health, Fertilizer and Water-Use Efficiency.* Conference Paper, University of Idaho Potato Conference. Available at https://www.researchgate.net/publication/286928913_30_YEARS_OF_RESEARCH_DOCUMENTS_THE_INFLUENCE_OF_HUMIC_SUBSTANCES_ON_SOIL_HEALTH_FERTILIZER_AND_WATER-USE_EFFICIENCY
9. USDA-NRCS Video Series: *Unlock the Secrets in the Soil,* Chapter 5, Keep a Live Root in the Soil, or "A Radicle Idea." June 10, 2016. Available at https://youtu.be/godG4MJeQvQ.

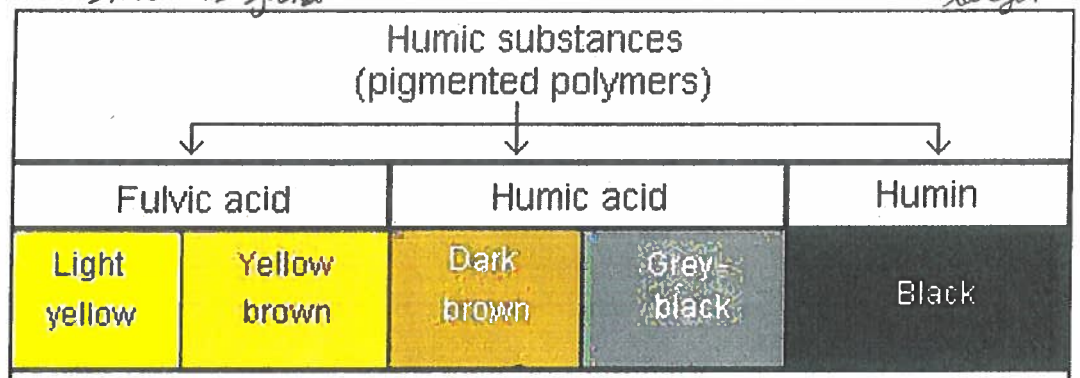
Humic acid molecule

lots of sites to hold other nutrients



Smaller molecules

larger



	increase in intensity of colour	→
	increase in degree of polymerization	→
2 000	increase in molecular weight	→ 300 000 ?
45%	increase in carbon content	→ 62%
48%	decrease in oxygen content	→ 30%
1 400	decrease in exchange acidity	→ 500
	decrease in degree of solubility	→

Chemical properties of humic substances. (Stevenson 1982)