Harnessing the Power of Microbes

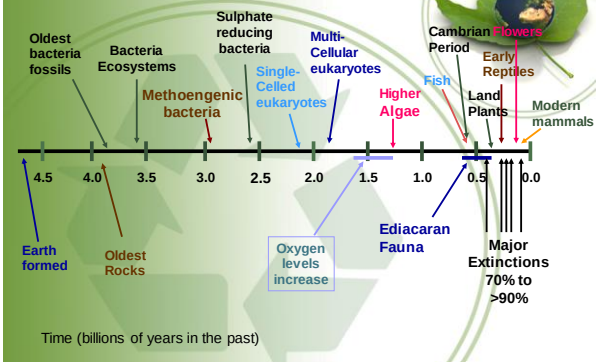
Improving Project Outcomes &
Improving Soil, Plant and Animal Health

Linda Miyoshi
Mid-Atlantic Microbials, LLC
linda.miyoshi@gmail.com

Why Microbes?

- Microbes are the basis of any sustainable system-and the basis for the soil food web.
- Chemicals and what we are doing now is not working.

Timeline of Life on Earth



Classification of Soils

- According to pH
- According to physical properties

- OR according to microbial makeup
- Disease Inducing soil
- Disease Suppressive Soil

Disease Inducive Soils

Poor management practices:

- Over tillage
- Heavy chemical use
- No or low inputs of organic matter
- Mono cropping
- Catastrophes

Disease Suppressive Soil

- The microflora of disease suppressive soils is usually dominated by antagonistic microorganisms that produce copious amounts of antibiotics.
- These soils typically have a low population of soil borne pathogens, including Fusarium.
- In disease-inducing soils Fusarium can be as much as 20% of the soil microflora..

Building Disease Suppressive Soils

- Add Organic Matter
  - Crop Residues
  - Cover Cropping
  - Compost/ Compost Tea
- Increase Beneficial Microbe Populations
- Increase Other Beneficial Organisms
- No Till/ Better Soil Aggregation

Classifying Soils According to Microbial Activity

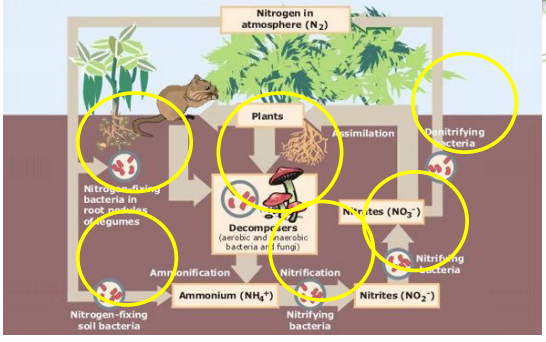
- Disease-Inducing Soils
  - Insoluble nutrients, compacted, high in pathogens
- Disease-Suppressive Soil
  - Lots of microbes, crumbly, water retention
- Zymogenic Soils
  - Fermentative microbes dominate, soft soil, nutrient-rich
- Synthetic Soils
  - Nitrogen-fixing bacteria dominate, water is stable, soil is fertile with low inputs, low or no diseases

- Zymogenic Soils are soils where fermentative microorganisms predominate. The soil has a fragrant smell: lactic acid bacteria, yeast predominate, Fusarium is below 5%. Aggregation stability is improved. Amino acids, polysaccharides, vitamins in the soil are increasing.
- Benefits are increased yields due to more nutrients being available, better water retention.

- Synthetic Soils
- Synthesizing everything the plant requires from the soil. This is true sustainability.
- Nitrogen-fixing bacteria dominate, water is stable, soil is fertile with low inputs, low or no diseases

- Lactic Acid Bacteria: produces lactic acid from the sugars and carbohydrates produced by yeasts and photosynthetic bacteria. Lactic acid bacteria has a strong sterilizing effect that can suppress harmful microbes like fusarium which can result from continuous cropping. Can also help reduce nematode populations. It inhibits growth of pathogenic microorganisms by lowering pH. Improves the absorption and utilization of calcium, phosphorous and iron. Helps break down cellulose and lignan.
- Yeasts: Produce bioactive substances such as polysaccharides, hormones, enzymes and amino acids useful for cell and root division. They are a source of vitamins and become food for other microbes.
- Phototrophic Bacteria: Helps to decompose organic matter, plays an important role in nitrogen and carbon cycling. They fix atmospheric nitrogen. Synthesizes amino acids, nucleic acids, Vitamin C precursors. They use sunlight and heat of the soil for energy sources. Their metabolites promote plant growth and development. They are facultative, can exist in the presence of O2 or without O2.

Nitrogen Cycle



Mycorrhizae

- Symbiotic root-fungus relationship
- Important for plant growth
- This relationship goes back 450 million years
- Finds and retrieves, unlocks critical Phosphorous and other nutrients for the plant
- 90 to 95% of plants form mycorrhizae in their root network

Pumpkin Trial
This summer a client of ours started a field trial with pumpkins in Southern Arizona. The trial was done at a farm in San Simon, Arizona. The fields are irrigated with drip irrigation. Activated EM-1® was used in conjunction with conventional fertilizer, humate, and micronutrients. Three applications of Activated EM-1® were applied to total 40 gallons in the soil. No product was applied foliarly.

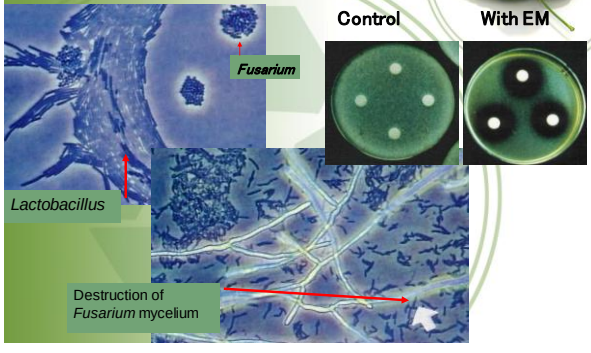
The only difference between the Activated EM-1® plot and the control was the addition of Activated EM-1®. Final yields were 45 boxes per acre on the control and 54.52 boxes per acre on the Activated EM-1®-treated plot. The observations from the soil and plant tissue analysis are as follows:

1. Organic matter increased with Activated EM-1® (from 1.02 on 5/13/10 to 1.25 on 7/26/10)
2. pH decreased with Activated EM-1® (from 7.8 on 5/13/10 to 7.6 on 7/26/10)
3. N-P-K increased with Activated EM-1® (from
   Nitrate NO3 36.95ppm on 5/13/10 to 76.35ppm
   Phosphorous 19.8mg/kg on 5/13/10 to 21.1 mg/kg on 7/26/10
   Potassium 44ppm on 5/13/10 to 82ppm on 7/26/10
4. Powdery mildew was less severe with Activated EM-1® use.

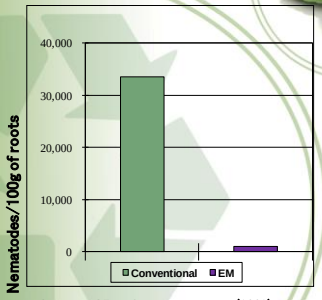
Soil Analysis

Nutrient	Initial Soil Test	40 gal AEM1	No EM1	Units	Difference
Ca	11.5	29.5	3.15	meq/L	-8.35
K	44	82	36	ppm	-8
Mg	2.73	6.62	0.85	meq/L	-1.88
NO3 N	36.95	76.35	41.3	mg/Kg	4.35
P	19.8	21.1	16.2	meq/L	-3.6
Na	26.2	31.2	17.8	meq/L	-8.4
Sulfate	28.32	46.81	11.69	meq/L	-16.63
SAR	9.82	7.34	12.59		2.77
EC Soil	3.78	5.28	2.09	mmhos/cm	-1.69
Organic Matter	1.02	1.25	0.94	percent	-0.08
pH	7.8	7.6	8		0.2

Effect of EM・1® against Fusarium Mycelium Growth



Effect of EM・1® for Reducing the Number of Nematodes (Radophlus Similis) in Banana



Source: EARTH Commercial Farm (2002)

EM・1® Decreases Fusarium in Flower Production

Treatment	pH	Bacteria (cfu/g)	Fungus (cfu/g)	*Fusarium oxysporum* (cfu/g)
Control (without EM)	7.2	5×10^6	1.1×10^5 = *Trichoderma*	2.0×10^3
Soil with EM Application	7.8	6.6×10^7	7.0×10^4 = *Trichoderma* 1.0×10^4 = *Penicillium* 3.0×10^4 = *Rhizopus* 3.0×10^3 = *Mucor*	ND

Effect of EM・1® for Reducing Infection of Xanthomonas Campestris PV Vesicatoria in Sweet Pepper

Treatment	Leaves per plant (No.)	Disease Index (%)
Control	158.1 a	30.9 a
Fungicide	231.9 b	28.8 ab
EM	214.8 b	24.9 b

(Castro et al. 1993)

Foliar Pathogens

- During extended wet conditions nutrients and photosynthates come to the surface of the leaf as exudates and provide food for microbes.
- If active microbial pathogens, such as Bacterial Leaf Spot, are present they will try to dominate the exudates, thereby infecting the plant.

Defending the Leaves

- By innoculation of the leaves with beneficial living microbes, one is in effect occupying the territory of the leaf against the prospective invader, a process called competitive exclusion.
- Beneficial Microorganisms produce substances such as bacteriocins and antimicrobial substances restricting the ability of the pathogenic organisms to compete.
- This acts as a living shield which disrupts the colonization by pathogens

Functions of Harmful Microorganisms

- Induction of plant diseases
- Stimulation of soil-borne pathogens
- Immobilization of plant nutrients
- Inhibition of seed germination
- Inhibition of plant growth and development
- Production of phytotoxic substances

Functions of Beneficial Microorganisms

- Fixation of atmospheric nitrogen
- Decomposition of organic wastes and residues
- Suppression of soil-borne pathogens
- Recycling and increased availability of plant nutrients
- Degradation of toxins including pesticides
- Production of antibiotics and other bioactive compounds
- Production of simple organic molecules for plant uptake
- Binding of heavy metals to limit plant uptake
- Making insoluble nutrients sources available to the plant
- Production of polysaccharides to improve soil aggregation

Benefits of Adding Microbes and Cultivating Microbial Populations

- Healthy Plants/Higher Yields/Higher Brix
- Better Soil Aggregation
- Less inputs needed/less runoff/pollution
- Crops are more Nutrient Dense
- Improve Crop Quality
- Improve Nitrogen Cycling
- Accelerates Soil Building

Benefits of Microbials

Numerous antioxidant bioactive vitamins such as:

- Vitamin A (Retonin), B1, B2 (Riboflavin), B3 , (Niacin), B6, B9, B12, C, Folate

Bioavailable trace minerals such as:

- Iron, Calcium, Potassium, Magnesium, Copper, Manganese, Phosphorus, Selenium, Zinc, Chromium
- Organic acids
- Lactic, Acetic, Carbonic

Benefits of Microbials

- Transforms organic material into organic fertilizer, maximizes conversion of organic matter into stable soil humus, and improves soil structure.
- Reduces oxidative forces that rob the soil of C and N in the form of methane and ammonia gases.
- Increases beneficial microbial populations and suppresses pathogen growth.
- Increases nutrient availability and improves crop quality.
- Faster seed germination

Benefits of Microbials

- Enhances root and plant development
- Improves plant health
- OMRI listed for use in organic farming operations
- Ingredients are GRAS listed (Generally Regarded as Safe)
- No PPE, Reentry, or Harvesting restrictions
- Beneficial in maintaining uncontaminated plant products and reducing the threat of E. coli and other pathogens of concern in the fresh produce industry.

Benefits of Microbials

- Anti-fungal Activity
- Lipopeptides capable of puncturing and disrupting fungal pathogen cell membranes.
- Anti-bacterial Activity
- Bacteriocins such as Subtillin and Plantaricin are produced by the beneficial bacteria.
- Bacteriocins are proteinaceous toxins that can inhibit the growth of pathenogenic bacteria.

Benefits of Microbials

The biochemicals contained in microbial chemistry confer numerous beneficial attributes such as:

- Enzymatic Activity
- Chitinase enzymatic activity which can break down glycositic bonds in fungi and the exoskeleton of nematodes.

Other enzymes include:

- Peptidase, Esterase-lipase, Catalase, Lipase, Phosphatases, Polygalacturonase, Phytase, Carbohydrases, Amylase, Azoreductase.

Without Microbes

With Microbes

Microbes:Job on the Farm

- Increase nutrient availability
- Increase crop yield/ quality and quantity
- Promotes soil formation, structure and porosity
- Builds up organic matter in the soil quickly
- Composts in a quarter of the time, with no turning
- Improves root development, prevents runoff, establishes plants quickly
- Cleans water
- Increases Brix scores/ healthier plants
- Cleans out drip tape
- Maintains septic
- Maintains waste lagoons/ creates a cleaner environment for the animal
- Antioxidant- prevents equipment from rusting
- Reduces odor from animal wastes
- Breaks down ammonia
- Increases grow out weights for animals
- Makes farmers happy

"The maintenance of the fertility of the soil is the first condition of a permanent system of agriculture."

-- Sir Albert Howard 1940

"We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong we may begin to use it with love and respect."

-- Aldo Leopold