Gardening Really is All About the Soil: Always Was & Always Will Be!

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Urban Horticulture Agent/MG Coordinator
Present Day Gardening!
I found an insect, what to do?
Typical thought is.....

* I should I spray something
Are Pesticides the Answer?

* Pesticides, at best, are just a Band-Aid. At their worst, they kill the good guys!
How Does Nature Grow Healthy Plants?
The Answer is in the Soil!

That is, a biologically active soil!
According to the (ii) definition of soil by the USDA soil is -- The unconsolidated mineral or organic material on the surface of the Earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro-and microorganisms acting on parent material over a period of time.

What do I mean by “Soil”?
Emphasis on Organic Matter

The soil must have organic matter for the soil organisms…
What lives in the Soil?

* A variety of micro and macro-organisms which eat and/or are eaten by each other! That is what we refer to as the Soil Food Web.
Soil Food Web, Who eats whom?

<table>
<thead>
<tr>
<th>The consumed</th>
<th>Primary consumers</th>
<th>Secondary consumers</th>
<th>Tertiary consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>-- plants</td>
<td>-- slugs</td>
<td>-- bacteria</td>
<td>-- beetles</td>
</tr>
<tr>
<td>-- mosses</td>
<td>-- nematodes</td>
<td>-- fungi</td>
<td>-- earth-worms</td>
</tr>
<tr>
<td>-- algae</td>
<td>-- insects</td>
<td>-- centipedes</td>
<td>-- ants</td>
</tr>
<tr>
<td>-- lichen</td>
<td>-- bacteria</td>
<td>-- mites</td>
<td>-- birds</td>
</tr>
<tr>
<td>-- some bacteria</td>
<td>-- fungi</td>
<td>-- spiders</td>
<td></td>
</tr>
<tr>
<td>(photosynthesizers)</td>
<td></td>
<td></td>
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</tbody>
</table>
The Main Players:

- Fungi
- Bacteria
- Arthropods
- Nematodes
- Protozoa
- Earthworms
* Majority of biomass in soil is typically fungi.
* Hyphae help to improve soil structure
  * Soil aggregation
  * Important to water holding capacity and aeration
* Fungi active in decomposition of plant material.
  * Decompose lignin with extracellular enzymes
  * Lignin peroxidases
  * Provide small “bite size” chunks of molecules for bacteria.
  Hyphae help to improve soil structure
Fungi usually get a bad wrap but here is a good guy in action!
Mycorrhizae – A Gardener’s Friend

* Mycorrhizal (myco=fungus, rhizal=root) fungi
* Extend root systems of plants
  * ~90% of all land plants colonized
* Symbiosis based on phosphorus transfer from soil to plant
* Key factor in the initial colonization of land by plants
* Corn is colonized by 80% of the mycorrhizae
* Spores are produced in the soil
Endomycorrhizae

Vesicular-arbuscular (VAM) penetrates inside the cell and are the most abundant in systems where phosphorus is limited and in warmer or drier climates.
Ectomycorrhizae

These can actually form a physical barrier to protect the roots
Benefits Ascribed to Mycorrhizae

- Improved nutrient uptake
- Increase tolerance of
  - Drought
  - Salts
  - Heavy metals
  - Pathogens
- Enhanced soil stabilization
Soil Bacteria

* Complex communities
* Over one billion bacteria per gram of soil
* Much more metabolically diverse than fungi
* Perform the most biogeochemical cycling of nitrogen, sulfur, and carbon of all microbes
* Biodegrade toxic chemicals
* Can fix nitrogen in legumes
* Can quickly create new biochemical pathway through genetic exchange!
Arthropods

* Animals with an exoskeleton
* Insects, crustaceans & arachnids
* Shred organic material which stimulates microbial activity
* Stimulate microbial activity
* Cycle nutrients
* Herbivores & Predators
Nematodes

- Microscopic
- Non-segmented
- Cycle nutrients
- Act as food source
- Root feeding type cause disease
- Some eat bacteria or fungi (suppress disease!)

Credit: USDA-ARS
Protozoa

* Single-cell & larger than bacteria
* Mobile
* Cycle nutrients (N when feeding on bacteria & other protozoa)
* Regulate bacteria populations
* Impacted by soil moisture for feeding & movement + type & size
* Active near plant roots
* Populations can reach 1 million per tsp in highly fertile soil
Earthworms

* Indicator of soil quality
* Burrowing mixes soil
* Ingestions of soil material
  * decomposition of plant residues
  * nutrient cycling
  * Castings create aggregates
Why is the soil microbial community so important to ecosystem function??
Carbon, nitrogen, phosphorus are essential nutrients for all life.

Carbon, Nitrogen, Phosphorus, etc are converted from inorganic to organic forms, and back to inorganic forms again.

Key links in cycles performed by soil microorganisms.
Fungal Degradation of Wood
Proposed structure of lignin
... and bacteria mop up
Healthy Soil = Healthy Plants
Healthy Soil & Plants Need Nutrients

* Supplied by air & water - Hydrogen (H), Carbon (C) and Oxygen (O)
* Supplied in fertilizer - Nitrogen (N) for foliage, Phosphorus (P) flowers/fruit, and Potassium (K) roots
  * Calcium (Ca), Magnesium (Mg) and Sulfur (S)* - * Needed in smaller amounts & can be supplied by fertilizer, gypsum, limestone, dolomitic limestone and Epsom salts.
* 7 referred to as micronutrients; Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mo), Boron (B), and Chloride (Cl). (needed in trace amounts & may be supplied by a fertilizer, liquid seaweed or microbial activity.)
* Other beneficial elements include; Cobalt (Co), Nickel (Ni), Sodium (Na), Silicone (Si) and Vanadium (V)
The Four Stages of Plant Growth

1. **Successful Photosynthesis**
   - Formation of complete complex carbohydrates such as starches and other polysaccharides which build resistance to soil-borne fungal pathogens.

2. **Production of Complete Proteins**
   - Transfer of sugars through roots to soil microbes which release nutrients in a plant-available form. Increased resistance to insects with simple digestive systems.

3. **Storage of Surplus Energy**
   - Energy is stored in the form of lipids, fats, and oils. Lipids build strong cell membranes for increased resistance to all airborne pathogens, parasites, disease, and UV radiation.

4. **Production of Plant Secondary Metabolites (PSM)**
   - PSMs act as plant protectants to guard against ultraviolet radiation, disease, and insect attack.

4. **Resistance to Cucumber Beetles, Colorado Potato Beetles, and Japanese Beetles; Production of Advanced Anti-fungal Compounds and Digestion Inhibitors.**

If we wish to produce “food as medicine” this is where the medicine is.

http://www.advancingecoag.com/ leading regenerative farming
The Ultimate Gardeners Goal

* To create a soil that **builds organic matter** to support a healthy soil food web! Yep, it’s that simple.
Research at the Univ. of Illinois has shown that the use of synthetic fertilizers does not build soil organic matter!
Gardening Practices to Build OM

- Add organic matter (OM)
  - Use as mulch around plants
  - Topdress turf with ¼-1/2 ”
- Use organic fertilizers
  - Jobe’s Organic has bacteria and mycorrhizae microbes
- Use biostimulants on the plants and soil
  - Liquid seaweed
  - Milk
  - Molasses
  - Humic acids, etc.
Gardening Practices to Build OM

- Re-mineralize the soil
  - Sea minerals (i.e. SEA-90)
  - Rock powder (i.e. Azomite)
- Minimize soil disturbance
  - No regular tilling
  - Chop & drop
- Cover the soil
  - Cover crops
  - Mulches
Gardening Practices to Build OM

* Increase biodiversity above ground to increase biodiversity below ground
* Amend the soil with biochar (also called bio-carbon or fixed carbon)
* Add soil organisms (worms and soil microbes) Many organic fertilizers include soil microbes
* Biologically active soil produces healthy plants that don’t require pesticides!
* Organic matter is food for the soil food web.
* Supply of nutrients allows plants to achieve stage 4 growth
* Insects & diseases are a sign of plant stress which are often caused by a lack of nutrient(s)
* Thank you to Andy Ogram, UF Professor Soil & Water Science Dept. & Amy Shober previously at UF IFAS Gulf Coast REC
Any questions?

TIGER by Bud Blake

MY MOM SAID THE SOIL IN HER GARDEN WAS RICH, BUT...

NO MONEY?

I COULDN'T FIND ANYTHING BUT DIRT!