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How to Add Life to the Soil (and plants!) for healthy plants, nutritious food & excellent water quality

Did you know that there is an entire ecosystem that lives in the soil and takes commands from plants? This ecosystem is the soil food web (SFW). This is nature's way of fertilizing her plants without the use of any synthetic fertilizers, pesticides, or irrigation!

Earth's Early History

Long before terrestrial plants appeared, fungi were breaking down the rocks and bacteria were helping them to create soil that terrestrial plants would eventually grow in. The microbes were already thriving when plants began to grow on the land. The base of the SFW is bacteria and saprophytic fungi, the **decomposers** of dead organic matter. Bacteria decompose green plant material, whereas only fungi can decompose wood into smaller chunks which are then decomposed by bacteria. Other types of soil microbes present are the **symbionts**, consisting of the mycorrhizal fungi and nitrogen-fixing bacteria, which form symbiotic relationships with plants. The plants share sugars with the mycorrhizae and bacteria, in the form of root exudates. The mycorrhizae gather the nutrients and water that the plant requests and the bacteria fix nitrogen in the roots of legumes or in the soil if they are free-living. The next level of the SFW is the **predators** which feed on the bacteria and fungi. The two groups of predators are the protozoa (amoebae and flagellate) and the nematodes which are categorized by their food source of bacteria, fungi, or nematodes. When there are not enough predators present, plants can exhibit nutritional deficiencies.

Landscaping Practices that Harm the SFW

Activity	Harmful Effect
Soil disturbance (tilling/plowing)	Rips apart the hyphae of fungi, destroying them. Most soils lack fungi.
Land clearing	Destroy & remove the fungi and other members of the SFW. The use of heavy equipment also compacts the soil. Compaction destroys soil structure, creating anaerobic soil. These conditions turn succession backward so only weeds will grow best.
Typical subdivision development practices	Retention ponds are dug, and material is used to build up land where the homes and roads are built. Heavy equipment compacts the soil and when the clay is present, a hard pan is created.
Parking vehicles and storing material on the soil.	The weight of vehicles, and equipment. construction supplies, etc. compact the soil, suffocating the SFW.
Use of synthetic fertilizer.	These products are salts that kill the microorganisms.
Use of synthetic pesticides.	Synthetic pesticides also kill members of the SFW. (Kalia et al., 2011) (Sofo et al., 2012)

Services Provided by the SFW

Microorganism(s)	Service Provided
Bacteria	**<Decomposes** green plant material. **<Remediate contaminated soil** by breaking down toxic substances.
Bacteria & Fungi	**<Protects against soil erosion**. Bacteria produce copious amounts of glue which bind soil particles together and the hyphae of fungi bind them together to create aggregates. **<Builds soil structure** that allows oxygen, water, and roots to grow deep into the soil
Fungi	**<Decomposes wood** – accomplished by saprophytic fungi. **<Creates organic matter** which increases the water and nutrient holding capacity of the soil. **<Protects water quality**. **<Sequesters** the most **carbon** in the soil.
Fungi – Mycorrhizal (both endomycorrhizae and arbuscular mycorrhizae (AM) & ectomycorrhizae)	**<Eliminates the need for fertilizers** because they form symbiotic relationships with plants, gathering phosphorus, water, and other nutrients for the plant**.** **<Protects plant roots from soil-borne pathogens and nematodes** because ectomycorrhiza forms a physical sheath around the roots**.**
Protozoa	**<Cycles nutrients** when feeding on bacteria, fungi, and nematodes**.**
Nematodes	**<Cycles nutrients** when feeding on bacteria, fungi, and nematodes**.** **<Protects plant roots** from root-feeding nematodes.
SFW	**<Increases yields** by supplying adequate nutrition and water as needed. **<Suppresses weeds** by creating an aerobic environment due to the good soil structure. **<Eliminates the need for irrigation** due to the increased water holding capacity (of the organic matter) that is in the soil. **<Inhibits insects & diseases** when more than 70% of the phyllosphere* is covered with the SFW.

*Phyllosphere is the above-ground portions of a plant which includes the foliage, stems, flowers, and fruit.

Methods for Adding Life to the Soil

- **Thermal composting,** when done correctly, is a great way to cultivate the correct SFW for the desired plants. (*Bulletin available*)
- **Vermicomposting** is an easier way (compared to thermal composting) to cultivate the correct SFW. (*Bulletin available*)
- **Aerated Compost Teas** (A.C.T.) can be brewed and used as a foliar spray to protect against diseases and insects. If compacted soil is present, inject the A.C.T. into the ground where the compaction is. A penetrometer can be used to detect compaction depth. (*Bulletin available*)
- **Compost extracts** can be created and used as a soil drench to boost the SFW. (*Bulletin available*)
- **For new or established plants** refer to the table on page 5.

Dry product	Liquid product
Plant Success Granular Mycorrhizae 19 spp. of endo & ectomycorrhiza, plus saprophytic fungus, humic acid, etc. Sprinkle in hole when planting.	**Agrispon** is a natural biostimulant that increases microbial activity and helps to loosen compacted soil.
Guard-N-Seed Inoculant** **Important inoculant when growing legumes.** Good for beans, peas, sweet peas, etc. N-fixing bacteria. **Treat seeds before planting.**	**Bushdoctor Microbe Brew*** 16 spp. bacteria, 13 endo & 11 ectomycorrhizae spp., 2 saprophytic fungi spp., 2 spp. N-fixing bacteria, 1 sp. that will detox soil. Use as a soil drench.
Exceed EL (or Garden combo) Type ** legume inoculant – **inoculates the largest number of legumes!** Detailed information on Exceed EL legume inoculant is on the next page!	**High Tech garden supply Stump Tea*** - **Free Tea Tuesdays** Bring an empty gallon jug (or 2) and take home **freshly brewed tea**! 4 spp. bacteria, 4 spp. endomycorrhiza, 2 saprophytic fungi. Soak seeds. Mix 1 TBSP per gal. of water & drench the soil or **spray all over plants multiple times for disease control**!
	Xtreme Gardening Granular Azos* *Azospirillum brasilense* is a free-living, nitrogen-fixing bacteria. Can be used on new cuttings, transplants, and as a soil drench. *Great for ALL plants*!
When applying any liquid inoculants or watering plants that have been inoculated – be sure to use **rainwater** or **city water treated with humic acid** (i.e., **FossilFuel***, **Raw Humic***, etc.) to remove the chloramine used to keep the water pipes sterile and microbe free!	**Bushdoctor Kangaroots*** 15 spp. bacteria, 9 endo & 11 ectomycorrhizal spp., 2 saprophytic fungi spp., 2 sp. N-fixing bacteria and 1 sp. that will detox soil. Use as a root drench for seedlings, transplants on most plants**
	Nature's Solution Compost Tea packaged in a breathable bag! 6 endo & 5 ectomycorrhiza spp. Soil drench when transplanting, planting, or watering.

*****These products can be purchased locally at High Tech Garden Supply on SR 192 in Melbourne.

**Mycorrhizae increase the activity of the N-fixing bacteria in legumes because phosphorus is needed in the N-fixing process, so inoculate with endomycorrhizae also.

The following plants don't form mycorrhizal relationships. **Brassica plants** – broccoli, cauliflower, cabbage, mustard, Chinese cabbage, pak choi, turnip, kale, Chinese kale, kohlrabi, Brussels sprouts. **Amaranth family** – beets, Swiss chard, Celosia spp., Globe amaranth (Gomphrena sp.), Spinach. Plus – *Dianthus* spp. including carnations. Protea, Rushes & Sedges. Vegetables are underlined.

*****Exceed EL (or Garden combo) Type legume inoculant**

Inoculate the legume seeds with N-fixing bacteria for legumes. An EL Garden type inoculates the most legumes. Exceed EL (or Garden combo) Type inoculates the following legumes: Acalia (I believe this should be Acacia/Senna), Great North Beans, Pink Beans, Lentils, Adzuki Beans, Hairy Indigo, Purple Vetch, Deer Vetch, Alyce Clover, Hairy Vetch, Rough Pea, Joint Vetch, Asparagus bean, Jackbean, Scarlet Runner, Austrian Winter Pea, American Joint Vetch (*Aeshynomene americana*), Chinese Lespedeza (*Serica lespedeza*), Black Beans, Kangaroo thorn (*Acacia paradoxa*), Siratro (*Macroptilium atropurpureum*), Centro, Kidney Beans, Slender Bushclover, Common Lespedeza, Korean Lespedeza, Snapbeans, Common Vetch, Kudzu, Striped crotalaria, Cowpeas, Lablab, Sunn crotalaria, Cranberry Beans, Lima Beans, Sweet peas, Florida Carpon Desmodium (*Desmodium heterocarpon*), Manantha vetch, Tangier pea, Faba bean, Mung beans, Tepary bean, Field/Canning Beans, Narrowleaf Vetch, Velvet Bean, Field pea, Navy Beans, Wax Beans, Flat pea, Partridge Peas, Wild Indigo, Garden/String Beans, Peanut, Winged Bean, Garden Pea, Pigeon Pea.

If the seed is not pre-inoculated, certain procedures should be followed to ensure proper inoculation.

1.) Buy inoculant suited specifically for each legume planted. Inoculants have a limited life span, so it is important to check the expiration date.

2.) Never expose the package of inoculant to heat or direct sunlight (especially the dashboard of a truck), as this will kill the bacteria. To ensure viability, inoculant should be refrigerated.

3.) Most inoculants come packaged in a medium of peat, which is black. This material must be mixed with just enough water to form a "slurry."

4.) It is critical that the inoculant adheres to the seed. If not, the entire process may be useless. A commercial "sticker" should be used to stick the inoculant to the seed. Some sticking agents contain gum Arabic, which is recommended for its ability to sustain high numbers of bacteria on the seed. If a commercial sticker is not available, a solution of four parts water to one-part sugar can be used as a substitute. Do not use cola or soda pop as a "sticker" because the pH of most soft drinks is very low, and the acid solution may kill the bacteria.

5.) Dissolve the "sticker" in the water (if you do not use sugar water) and mix the inoculant as directed on the package to form a thick "slurry." Add slurry to seed and mix well, making sure all seeds are coated with an inoculant. The coated seed should be allowed to dry in the shade. DO NOT place in the sun to dry. The seed should be dry enough to sow in about an hour.

Properly inoculated seed may help Rhizobium produce up to 200 pounds of nitrogen per acre, depending on the species of legume selected. This is very beneficial in reducing fertilization costs, especially when following a legume crop with grass, such as corn, grain sorghum, wheat, or oats.

https://hancockseed.com/products/el-type-inoculant?variant=6174449762336&matchtype=&network=g&device=c&adposition=&keyword=&gclid=CjwKCAiAg9rxBRADEiwAxKDTujNWviWjANwIABTx5YOO9k1b8U58o2qhTJjBqA7M9ZTmja1Hf0sNHRoCsJ4QAvD_BwE

Suggested steps to take when adding life to the soil! ***if disease present, see next page***

Weedy or bare areas & compacted soil	**Sodding a new lawn**	**Planting new plants ***	**Established plants**
Plant turf plugs, ground covers, or ornamental plants & add both **worm castings** & a **granular inoculant** to the planting hole.	Prepare the area by removing all plant material (dead grass, weeds, etc.) and level the bare soil.	If desirable plants are already present or the soil is compacted, spray the soil with **Agrispon** a week prior to planting.	Spray the soil or drench the root system with **Agrispon** a week prior to inoculating the soil.
Water with **rainwater** or city water treated with **humic acid** (i.e., FossilFuel, Raw Humic, etc.) to remove chloramine. Can apply with a hose-end sprayer.	Scatter a thin layer of **earthworm castings** & a **biochar** product (i.e., Comand, Wakefield, etc.) or a **granular mycorrhizal inoculant** & lay the new sod on top.	When planting, place **worm castings** and a **granular mycorrhizal inoculant** in the planting hole. Next, scatter **worm casting** and mulch around the plant.	Consider planting new plants around and/or underneath the other plant(s) to increase the number of living roots and exudates available for the SFW.
Two weeks later, drench the plugs or plants with **Agrispon**. **For disease control, spray plants with freshly brewed Aerated Compost Tea**	Two weeks later, spray the sod with **Agrispon** using a hose-end sprayer. **(A.C.T.) (i.e., freshly brewed Stump Tea, Nature's Solution Compost Tea, or brew your own!)**	Use **rainwater** or city water treated with **humic acid** to remove chloramine and water in the new plants. Can apply with a hose-end sprayer or a watering can.	**Drench** the plant's roots with a **liquid inoculant*** (i.e., Microbe Brew) with Azos mixed in also.
Two weeks later, drench the plants with a **liquid inoculant*** (i.e., Microbe Brew) with Azos mixed in also.	Two weeks later, spray the sod with a **liquid inoculant*** (i.e., Microbe Brew) with Azos added & use a hose-end sprayer to apply.	Two weeks later, drench the plants with **Agrispon**. **Disease control, spray A.C.T. all over plants, repeatedly.**	Two weeks later, spray the soil with **Agrispon**. **Disease control, spray A.C.T. all over plants, repeatedly.**
*The **liquid inoculant** can be repeated if there is no noticeable improvement after 3-4 weeks. See the next page for inoculating the plant itself with the SFW.	Begin spraying with **trace elements** (i.e., Nitrozime, liquid seaweed, etc.) and **humic acid** product (i.e., FossilFuel, Raw Humic, etc.) using a hose-end sprayer (bi-monthly)	Two weeks later, drench the plants with a **liquid inoculant*** (i.e., Microbe Brew) along with some Azos. *See **previous page** regarding legumes.	For edible plants, begin spraying the leaves with **trace elements** (i.e., Nitrozime, liquid seaweed, etc.) and **humic acid** (i.e., FossilFuel, Raw humic acid, etc.) using a hand pump-up sprayer every week.

Very last step is to add red wiggler worms **everywhere** you have plants growing! Don't forget to also add life to the surfaces of the plants themselves, especially if they are prone to disease problems! Spray freshly brewed A.C.T all over the tree, vegetables, etc. This is extremely important for tomatoes, peppers, cucumbers, citrus, avocado, mango, grapes, etc.

Landscaping Practices for Promoting Soil Health

- ***If a soil-borne fungal pathogen is present or suspected***, inoculate the plants with a **liquid inoculant** containing beneficial bacteria and both endo and ectomycorrhizae. A month later, Scatter corn meal (right off the grocery store shelf) around the diseased plant(s). The **corn meal** will stimulate the good soil micro-organisms which keep the bad microbes under control. (*Research conducted at Texas A&M Research Station in Stephenville on organic peanuts*.) Gordon Food Supply on SR 192 sells large quantities of corn meal. After another month, inoculate the soil with **Trichoderma fungi** to help parasitize any pathogenic fungi that may still be present.
- If pesticides are needed, check this biorational database search engine https://attra.ncat.org/attra-pub/biorationals/ for pesticides that contain a microbe as the active ingredient (identified by their scientific name containing a genus and specie) that can be purchased here in the U.S.
- If fertilizer is needed (until the SFW gets established) use an organic fertilizer. A great one to use, which will also increase the biological activity in the soil, would be to drench the soil around the plant(s) with a phosphoric acid stabilized fish hydrolysate (i.e., Neptune's Harvest Fish and Seaweed Fertilizer.)
- Minimize soil disturbance.
- Minimize driving and storing products on the ground.
- Keep the yard "trash" on site. Compost it or use the chop and drop method where pruned material is cut up and dropped around the plant to decompose. The smaller the pieces are cut and dropped around the plant, the more quickly they will break down.
- Broadcast **worm castings** periodically, or better yet, add **red wiggler worms** to your lawn, plant beds, etc.!
- Broadcast **biochar** that has been inoculated with microbes (i.e., Comand, Wakefield) over the lawn or around ornamental plants.

References

Kalia, A. and Gosal, S.K., 2011. Effect of pesticide application on soil microorganisms. *Archives of Agronomy and Soil Science*, *57*(6), pp.569-596.

Sofo, A., Scopa, A., Dumontet, S., Mazzatura, A. and Pasquale, V., 2012. Toxic effects of four sulphonylureas herbicides on soil microbial biomass. *Journal of Environmental Science and Health, part B*, *47*(7), pp.653-659.

Suggested Reading: The Soil Will Save Us by Kristin Ohlson; 10 Steps to Gardening with Nature by Carole Ann Rollins & Elaine Ingham; Teaming with Microbes & Teaming with Fungi by Jeff Lowenfels & Wayne Lewis; Finding the Mother Tree by Susan Simard, Nourishment Home Grown by Dr. A.F. Beddoe D.D.S.; The Anatomy of Life & Energy by Charles Walters, Minerals of the Genetic Code by Charles Walters.

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