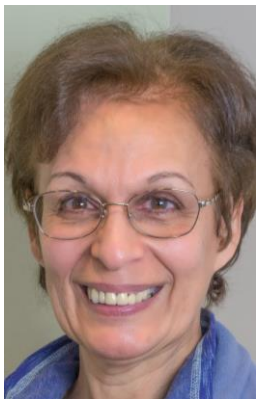
What's in your Soil?



By Marisa Earnst
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A soil food web

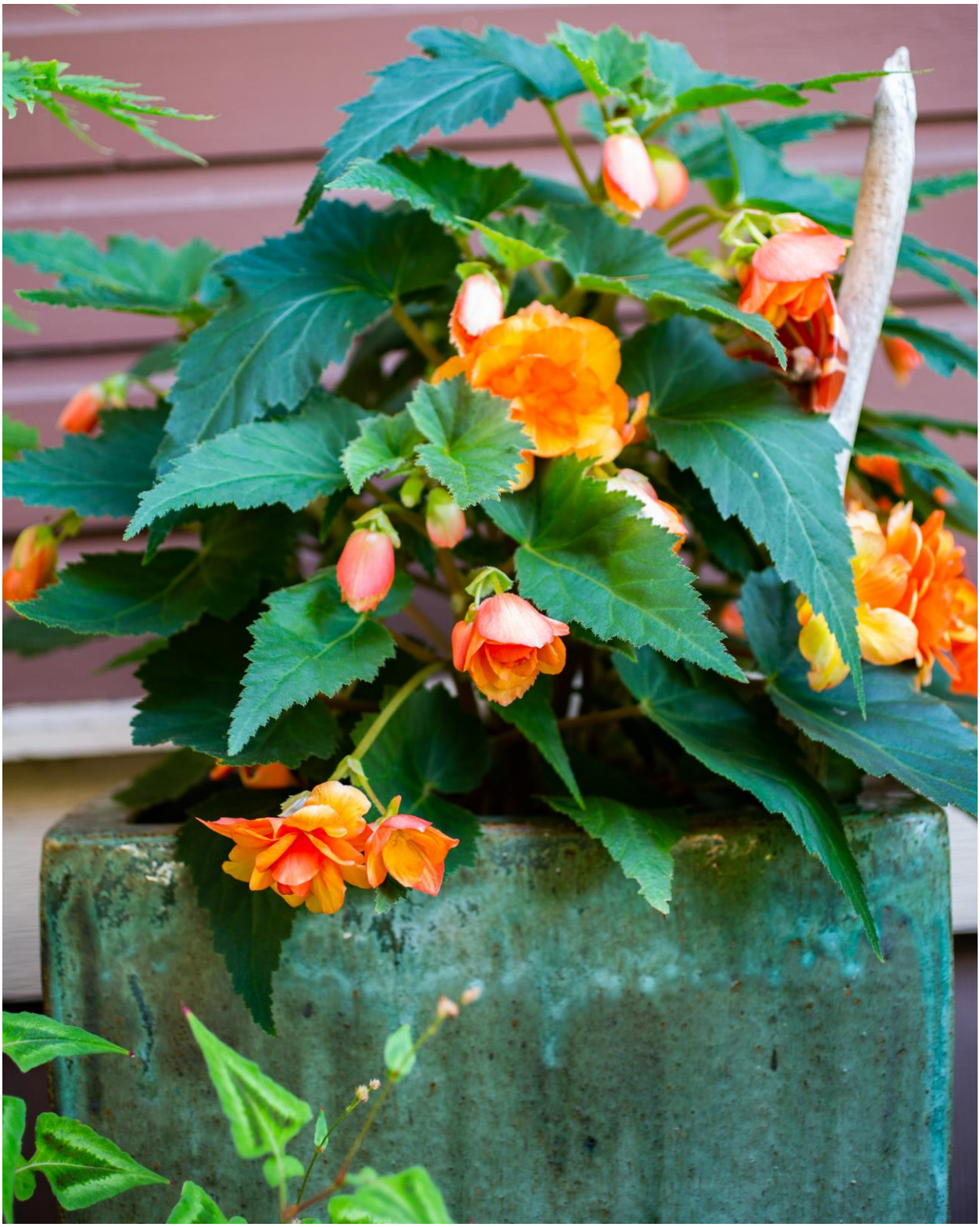
It's a whole wild world in that soil! In a gram of healthy soil there are a billion bacteria, hundred million fungi, 10-100,000 protozoa and nematodes. Most bacteria need carbon (plants, waste products or bodies of other organisms) to survive. If you draw a diagram of who eats whom, you will get a soil food web.

Plants help themselves by creating chemicals they exude through their roots in an area called the rhizosphere. Root exudates attract and grow specific bacteria and fungi living in the soil. The bacteria are eaten by nematodes and protozoa and the waste is absorbed by the plant's roots as nutrients. Protozoa and nematodes are eaten in turn by arthropods (insects and spiders). Arthropods eat each other and are also eaten by snakes, birds, moles, and other creatures. Nothing goes to waste.

Soil structure – Bacteria need to stick to things to prevent being washed away, so they produce a slime, which makes individual soil particles stick together and create pores through which air and water can travel. Fungal hyphae (or branching filaments that make up the mycelium of a fungus) travel through soil particles binding them together into aggregates, also creating pores for oxygen and water to flow through. Earthworms, insect larvae and moles and other burrowing animals create pathways that allow air and water to enter and leave the soil. All this activity creates soil structure.

Soil food web produces nutrients. When a member of the soil food web dies or is eaten by another, fungi and bacteria go to work by decaying the organism or working on the dung of the eater. Nutrients are preserved and absorbed by roots. The total amount of fungi and bacteria in the soil determines mostly the amount of nitrogen available for plant use. In general, the least disturbed soils (woods with old growth) have more fungi, the ratio being 10:1 fungi to bacteria. Disturbed soils (rototilled) have more bacteria, the ratio being 1:1 fungi to bacteria. In general, perennials, trees and shrubs prefer fungally dominated soils; while annuals, grasses and vegetables prefer soils dominated by bacteria.

When organisms are eaten, large amounts of nitrogen are released as ammonium (NH_4^+). Depending on the soil environment, it may be converted to nitrate (NO_3^-) by special bacteria, if bacteria dominate the soil. Chemical fertilizers provide nitrogen mostly in the form of nitrate, which is highly soluble in water and can leach out of the soil into bodies of water, harming water



Follow the product's label instructions on the plant so you don't harm the plant or the environment. *Photo by Jessamyn Tuttle / WSU Skagit County Extension Master Gardeners.*

organisms and creating imbalance among them. Furthermore, plants that prefer fungally dominated soils won't flourish on a diet of nitrates.

How can the soil food web control disease? Not all organisms in the soil are beneficial. There are bad guys, including some bacteria and fungi. A healthy food web competes for exudates and other nutrients and even space in the rhizosphere. If there is no space for bad bacteria to attach because all space is taken by good bacteria, most likely the plant won't get infected. It is protected.

Chemical fertilizers, pesticides, insecticides, and fungicides affect the soil food web; they can be toxic to some members, ward off others, and change the environment. Fungal and bacterial relationships don't form when plants can get free nutrients. You must keep adding chemical fertilizers and using pesticides, because the right mix and diversity of organisms has been altered. Organisms move out or die. As a result, soil structure deteriorates making it harder for water to get in and out, pathogens establish themselves and gardening becomes more of a chore than it needs to be. Pesticides also affect beneficial organisms, the ones that work for us by getting rid of harmful insects. These are some of the reasons why these pesticides should be used as a last resort.

If you grow plants in containers, supplement with nutrients because the soil does not contain the microbes available in your garden soil. *Photo by Jessamyn Tuttle / WSU Skagit County Extension Master Gardeners*

The activity of soil organisms depends on soil moisture and temperature, as well as organic matter content. Soils with more organic matter tend to have more organisms. Garden activities, including tillage, use of fertilizers, manures and pesticides and the choice of crop rotations affect soil organism population and diversity. Amending soil with organic matter and rotating plantings tends to increase the number and diversity of beneficial organisms.

If you grow plants in containers, though, you need to supplement with nitrogen and other plant nutrients, because the soil does not contain the microbe world available in your garden soil, and nutrients are washed away every time you water. It is wise to follow the product's label instructions closely, so you don't harm the plant or the environment.

RESOURCES:

- "Teaming with Microbes, The Organic Gardener's Guide to the Soil Food Web." Jeff Lowenfels & Wayne Lewis, Revised Edition. Timber Press. 2010.

- WSU Master Gardeners Training Manual 2018.