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Soil, Carbon, and How Plants Will Save the World

by Jack Kittredge, editor

More and more agricultural scientists are beginning to recognize that there is a wondrous world just beneath our feet. We know very little about it, so far. But what little we are learning is staggering.

The rhizosphere (the narrow soil area immediately surrounding plant roots) is a densely populated zone where plant roots must compete with invading root systems of neighboring plants for space, water, and mineral nutrients, and with other soil-borne organisms, including bacteria and fungi. Root-to-root and root–to-microbe communications are continuous occurrences in this biologically active soil zone. How do roots manage to simultaneously communicate with and influence neighboring plants and symbiotic and pathogenic organisms within this crowded rhizosphere? Increasing evidence suggests that roots constantly exude chemicals that initiate and manipulate biological and physical interactions between roots and soil organisms, and thus play an active role in such communication and influence.

Green plants jumpstart the process using their chlorophyll and sunlight to magically create carbohydrates out of carbon dioxide and water. They use some of these sugars as the building blocks for further transformation into proteins, fats, antioxidants and phyto-chemicals of all sorts for their own growth and development. But a lot of the sugars, amino acids, proteins, organic acids, phenolics, and various other secondary metabolites will be exuded by the plant's roots into the surrounding soil as a way of 'hiring help' from bacteria, fungi, and countless other organisms in the soil community.

Such services as accessing minerals and water, fighting off attack by disease organisms, repelling predators, and inhibiting competition with other plants can often be done more efficiently by various non-photosynthesizing organisms which, in turn, need the carbohydrates and other root exudates of the plants for their own survival. The co-evolution of plants with the many specialized soil organisms which provide these services is one of the more fascinating fields of study just emerging for young biologists!

In this fashion sometimes as much as half the carbon a plant draws from the atmosphere will ultimately be exuded underground and enter the bodies of microbial organisms. While some of that is ultimately oxidized and released back to the atmosphere when those organisms die, some is further processed into complex humic compounds, capable of resisting oxidation and of enduring for centuries underground.

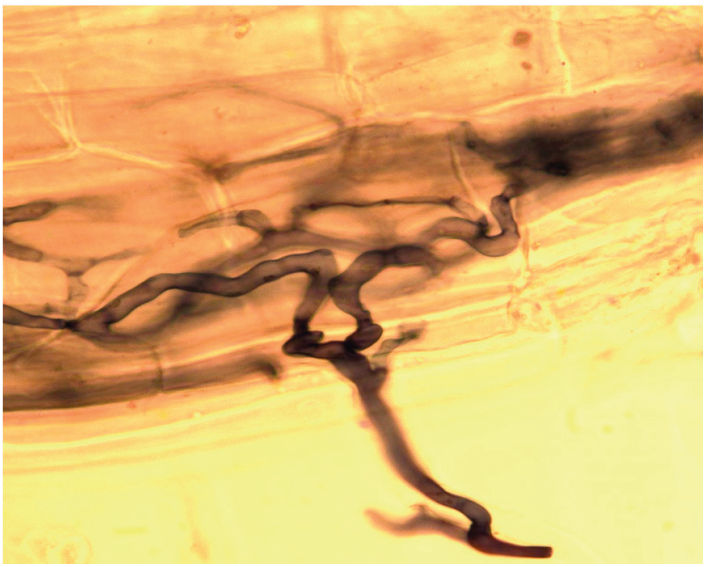

photo courtesy Jill Clapperton

Cross-section of a plant root, showing liquid carbon flowing to soil via the hyphae of mycorrhizal fungi. This carbon will support a vast array of microbes that not only retain carbon but also improve soil structure and soil tilth, enhance water-holding capacity, fix atmospheric nitrogen, solubilise phosphorus and provide minerals, trace elements and other growth stimulating substances to plants.

It is this process of drawing in carbon dioxide as a gas, and pumping that carbon underground as liquid carbon compounds, which has tied up carbon in the past and can continue to do so in the future. As you will see when you read this issue of The Natural Farmer, it is the only process that has any chance of counteracting the increasing CO_2 our combustion of fossil fuels is adding to the atmosphere.

To enable this process to deal with that much carbon dioxide, however, we need to enlist the aid of worldwide agriculture. The things which disrupt that process are bare soil which is not photosynthesizing, tillage which shreds fungal and other life forms vital to preserving soil carbon, and synthetic fertilizers (particularly nitrogen and phosphorus) because of their toxic impact on decomposer organisms. The ways to accelerate that carbon-fixing process are use of perennial crops and grasses, no till growing methods, biodiverse cover crops, livestock grazing, and the addition of stable carbonaceous materials (such as biochar) to soils.

In this issue we present what we hope is useful (and hopeful) information about soil and carbon. Every grower, whether raising annuals, perennials, or grazing animals, can adopt these methods and not only raise better and healthier products as a result, but also help nature take carbon from the air and return it to the soil.