AN INTRODUCTION TO SOIL BIOLOGY AND THE SOIL FOOD WEB

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Soil is teeming with an incredible diversity of micro-organisms which make up the complex underground ecosystem called the soil food web. These organisms range in all shape and size from the smallest virus, bacteria, algae, fungi and protozoa to the more complex nematodes and micro-arthropods, through to the visible earthworms, insects, small vertebrates and plants. As these organisms grow, eat and move their way through the soil, they perform a vast array of functions. These beneficial microbes decompose organic materials including manure and plant residues; fix atmospheric nitrogen and solubilise soil minerals into plant available form; store and recycle soil nutrients; enhance soil aggregation and porosity; degrade pesticide residues; build soil humus and hence increase nutrient and moisture retention; prey on crop pests and are even consumed themselves by higher level predators from the intertwined soil food web.

Who's who in the Soil Food Web

The soil foodweb is fuelled by the primary producers, namely: the plants, algae, lichens, moss and certain groups of bacteria that have the ability to fix carbon from the atmosphere. Other soil organisms then obtain their energy by consuming those primary producers and their waste products. As organisms decompose organic materials or consume other organisms, nutrients are converted from one form to another and some are made available to plants and other soil organisms. All crops – grass, vegetables and orchard crops depend on these interactions of the food web for their nutrition.

The four key players in the soil food web of particular interest to agricultural soils are bacteria, fungi, protozoa and nematodes. Bacteria are single celled organisms and reside in the soil in vast numbers – a teaspoon of soil generally contains between 100 million and 1 billion bacteria. Most bacteria are decomposers of simple carbon compounds but they also hold nutrients in the root zone, improve soil structure and filter and degrade pollutants. Fungi are multi-celled organisms that grow as long threads or strands called hyphae. Fungal hyphae can span in length from a few cells to many yards. Saprophytic fungi perform important services related to soil-water dynamics – they physically bind soil particles into aggregates thereby improving soil structure. They also decompose complex carbon compounds, retain nutrients in their fungal biomass and compete with plant pathogens. Protozoa are single celled animals that feed primarily on bacteria, but also eat other protozoa, organic matter and sometimes, fungi. As protozoa eat bacteria, excess nitrogen is released into the soil in plant available from. Nematodes are non-segmented tiny worms and many growers are familiar with the nematodes that cause plant disease, when in fact, there is an incredible variety of beneficial nematodes. These beneficial nematodes consume bacteria, fungi or even other nematodes and in doing so (similarly to protozoa) release nutrients in plant available from. It is this process of predators consuming lower hierarchical organisms and recycling nutrients in which highly productive natural ecosystems can maintain their fertility in the long term without the application of fertiliser year after year.

Ecological Succession

Ecological Succession refers to a predictable and orderly change in the composition or structure of an ecological community. In nature, we find a range of plant ecosystems such as pioneer species or early colonizers, grasslands, shrublands and soft and hardwood forest systems. Over time, there is a slow and gradual change through successional ecosystems as they increase their complexity eventually moving from pioneers to forest ecosystems. With these changes in plant communities also comes a correlated change underground in the soil micro-organism structure.

Food Web Structures

The structure of a food web is the composition and relative numbers of organisms in each group within the soil ecosystem. Each type of agro-ecosystem (be it grassland, vegetables or orchard) have a characteristic balance or specific food web structure in which they will thrive. In particular, the ratio of fungi to bacteria is a key characteristic to the type of system. Grassland soils usually have bacteria dominated food webs, meaning most of the biomass will be in the form of bacteria. Productive vegetable soils tend to have ratios of fungal to bacterial biomass nearer to 1:1, while forest and orchard soils tend to have fungal dominated food webs. The presence of predators in the food web reflects their food source, ie. protozoa or bacterial feeding nematodes are abundant where bacteria are plentiful. Management practices can change food webs; for example tillage practices, fertiliser and chemical applications, can have a negative influence on soil microbial communities while application of compost, compost tea and other organic amendments can have a positive effect on the soil microbial communities.

Soil Fertility Test at Laverstoke Park

The Soil Foodweb laboratory service at Laverstoke Park in Hampshire has been testing soil samples from UK and Europe for nearly two years. The lab service follows peer-reviewed scientific methods to measure the microbial biomass and diversity in soil. The Soil Foodweb labs have an evolving database currently consisting of biological results of over 100,000 samples from all over the world. The laboratory accesses this database to compare the clients' results to soils where the plant species are growing in native ecosystems. This information can be used by growers to determine the need for any organic amendment programs required to correct microbial imbalance in their soils. Growers are well aware of the importance of soil analysis for monitoring chemistry and the nutritional balance of their soils; however, monitoring the soil biology is much less commonplace even though, the biological activity of the soil is equally important to soil health (Figure1). Understanding the many roles that microbes perform in the soil highlights the importance of testing and monitoring how this 'living' component of the soil is faring under current management practices. Once the microbial balance has been determined, the necessary management practices or best course of action can be set in place toward improving the biological and overall fertility of the soil.

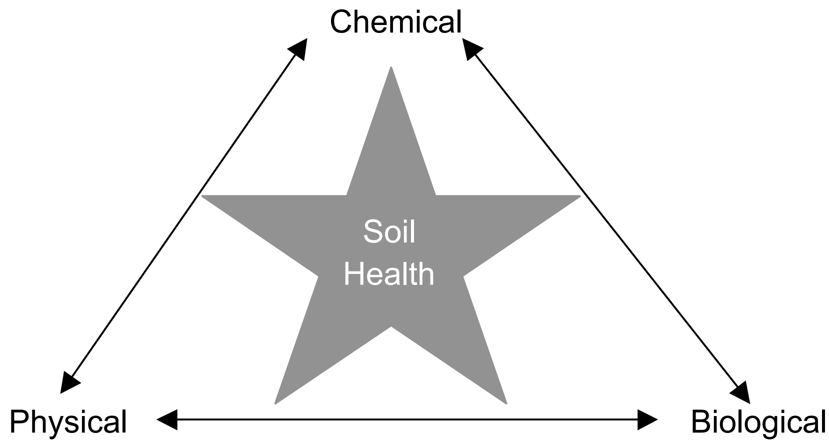

Figure 1: The soils chemical, physical and biological properties all equally influence soil health and fertility.

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