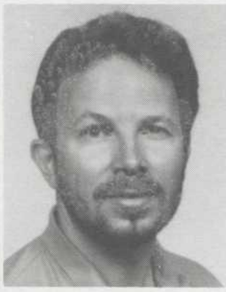
Part II



Soil

What is it anyway?

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COMPOSITION OF SOIL

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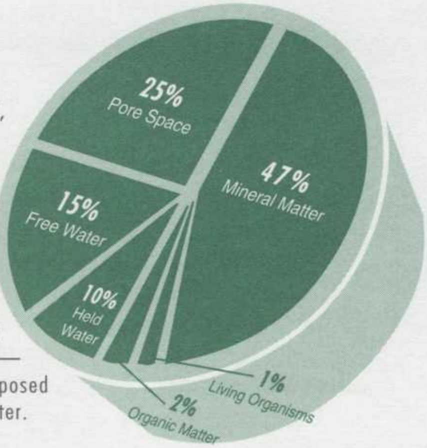

BEFORE WE BEGIN PART II of our microbial journey through soil, it is important to ask the question: What is soil anyway? Therefore, this month, I will give you a general overview of soil to provide the necessary background for the microbiological discussions to follow and to describe the environment in which these microorganisms function.

Soil is simply the loose, outer material of the Earth's crust. It accumulates from the weathering of rocks, the decay of organic materials, and the activities of man and other living organisms. Agriculturally, this is the zone from which plants obtain mechanical support and most of their nutrients. Biochemically, soil is distinctly different from the underlying bedrock, since many unique organic chemicals can be found there. Microbiologically, soil is unique in that it contains a diverse array of bacteria, actinomycetes, fungi, algae, protozoa, and microarthropods. It is, undoubtedly, one of the most dynamic sites of biological activity in nature.

Nearly all of the processes, transformations, and associations that are important for the maintenance of healthy turfgrass plants take place at the microscopic level—things such as nutrient cycling, organic matter degradation, nitrogen fixation, biological control of insects and pathogens, plant-microbe symbioses necessary for increased plant growth and pest resistance, and more. All of these important attributes of the plant-soil association are mediated by a plethora of microorganisms, without whose activities, managing turfgrasses would be a far more perplexing task than it is already.

Soil consists of five primary components: minerals, organic matter, water, air, and living organisms. For any given native soil, the mineral and organic matter content are relatively constant, while the air and water (i.e., pore space) can fluctuate widely. For most mineral soils, half of the soil volume is composed of pore space (air and water), with the other half composed primarily of mineral matter. Organic matter may account for 2–10% of the soil volume, the exception being organic soils where the organic matter content can range as high as 95%. Finally, small animals and microorganisms usually account for less than 1% of the total soil volume. Despite this small percentage occupied by living organisms, it is undoubtedly the most important component in terms of plant health.

The mineral components of soil, excluding stones, gravel, and foreign matter, are comprised of sand, silt, and clay. Sizes of these particles range from 0.05–2.0 mm for sand, 0.0002–0.05 mm for silt, and less than 0.0002 mm for clays. The relative proportions of these three inorganic materials in soils is the basis for the different textural classes, such as a clay loam, or a sandy loam. Loam is a soil with nearly equal proportions of all three mineral components. The different proportions of each of these inorganic components, along with organic matter, affect not only air and water movement and their retention in the soil, but also affect the nutrient-holding capacities and microbiological activities. For custom-made root-zone mixes used in golf course construction, all of the components may be varied and manipulated as desired.

Chemically, soils are, with the exception of organic soils, composed largely of silicon dioxide—generally 70–90% of the total mass. Aluminum and iron are usually abundant with lesser quantities of calcium, magnesium, potasssium, manganese, sodium, nitrogen, phosphorus, and sulfur. Carbon exists in soils in the form of decaying plant and animal material, living microbial cells, and humus (a by-product of the synthesizing and decomposing activities of microorganisms. Although the exact chemical composition of humus varies, it can be characterized as a dark-brown to black organic complex of humic and fulvic acids together with other polymerized organic molecules.

An important chemical feature of soils is their ability to retain ions. Ions are nutrient elements that have either a positive or negative charge. Ammonium (nitrogen), calcium, magnesium, and potassium are all positively-charged ions—or cations. Cations are readily removed from soil solutions by organic matter and clays. The soils ability to remove these cations is referrred to as the cation exchange capacity (C.E.C.). As might be expected, soils high in clay or organic matter content will have a higher cation exchange capacity than sandier soils. Ions—such as nitrates, phosphates, sulfates, and bicarbonates—are negatively-charged ions—or anions. These are not as readily retained in most soils, and are easily leached from the root zone during irrigation or rainfall.

Perhaps the most important soil component, from the point of view of microorganisms, is the organic fraction of humus. Humus, in the absence of any plants, serves as the dominant food reservoir for soil microorganisms. When plant or animal remains land on, or are incorporated into soil, microorganisms begin the process of decomposition, using the material for cell energy, as well as synthesizing new cell mass. During decomposition, a number of products are

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formed that become relatively resistant to further decay and persist for extended periods of time in the soil.

The physical and chemical characteristics of soil determine the nature of the environment in which microbes function. The specific soil environment further affects not only the types and numbers of microorganisms found, but their activities. These activities may be either beneficial to turfgrass growth and development or harmful, as is the case with pathogenic soil microorganisms. It will be the challenge of the turfgrass manager to manage this environment with care equal to the turfgrass environment, if healthy turfgrasses are to be maintained.

In the next article in this series, we will consider the types of microorganisms in soil and their important activities. ■

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