Lecture 10
Biological problems in soils

SOC and microbial population

Biological problems often results from management practices and anthropogenic influence. Soil organic carbon (SOC) is the main source of energy for soil microorganisms and a trigger for nutrient availabilitythrough mineralization. Humus participates in aggregate stability, and nutrient and water holding capacity. Organic acids (e.g., oxalic acid), commonly released from decomposing organic residues and manures, prevents phosphorus fixation by clay minerals and improve its plant availability, especially in subtropical and tropical soils. An increase inSOM, and therefore total C, leads to greater biological diversity in the soil.

Problems

A direct effect of poor SOC is reduced microbial biomass activity,and nutrient mineralization due to a shortage of energy sources. In non-calcareous soils, aggregate stability, infiltration, drainage, and airflow are reduced. Low SOC results in less diversity in soil biota with a risk of the food chain equilibrium being disrupted, which can cause disturbance in the soil environment (e.g., plant pest and disease increase, accumulation of toxic substances).

Improving Carbon Levels

No till farming, continuous application of manure and compost, and use of summer and/or winter cover crops. Burning, harvesting, or otherwise removing residues decreases SOC.

Earthworms

Earthworms play a key role in modifying the physical structure ofsoils by producing new aggregates and pores, which improves soil tilth, aeration, infiltration, and drainage. Earthworms produce binding agents responsible for the formation of water-stable macro-aggregates. They improve soil porosity by burrowing and mixing soil. As they feed, earthworms participate in plant residue decomposition, nutrient cycling and redistribution of nutrients in the soil profile. Their casts, as well as dead or decaying earthworms, are a source of nutrients. Roots often follow earthworm burrows and uptake available nutrients associated

with casts.

Problems

Low or absent earthworm populations are an indicator of little or no organic residues in the soil and/or high soil temperature and low soil moisture that are stressful not only to earthworms, but also for sustainable crop production. Earthworms stimulate organic matter decomposition. Lack of earthworms may reduce nutrient cycling and availability for plant uptake. Additionally, natural drainage and aggregate stability can be reduced.

Improving Populations

The practices that boost earthworm populations are Tillage Management (no-till, strip till, ridge till), Crop Rotation (with legumes) and Cover Crops, Manure and Organic By-product Application , Soil Reaction (pH) Management and proper irrigation or drainage

Soil Respiration

Carbon dioxide (CO_2) release from the soil surface is referred to as soil respiration. This CO_2 results from several sources, including aerobic microbial decomposition of soil organic matter (SOM) to obtain energy for their growth and functioning (microbial respiration), plant root and faunal respiration, and eventually from the dissolution of carbonates in soil solution. Soil respiration is one measure of biological activity and decomposition and also known as carbon mineralization.

Soil respiration reflects the capacity of soil to support soil life including crops, soil animals, and microorganisms. In the laboratory, soil respiration can be used to estimate soil microbial biomass and make some inference about nutrient cycling in the soil. Soil respiration also provides an indication of the soil's ability to sustain plant growth.

Problems

Reduced soil respiration rates indicate that there is little or no microbial activity in the soil. It may also signify that soil properties that contribute to soil respiration (soil temperature, moisture, aeration, available N) are limiting biological activity and SOM decomposition. With reduced soil respiration, nutrients are not released from SOM tofeed plants and soil organisms. This affects plant root respiration, which can result in the death of the plants. Incomplete mineralization of SOM often occurs in saturated or flooded soils, resulting in the formation of

compounds that are harmful to plant roots,(e.g. methane and alcohol). In such anaerobic environments, denitrification and sulphur volatilization usually occur, contributing to greenhouse gas emissions and acid deposition.

Improving Soil Respiration

The rate of soil respiration under favorable temperature and moisture conditions is generally limited by the supply of SOM. Agricultural practices that increase SOM usually enhance soil respiration.

Soil Enzymes

Soil enzymes increase the reaction rate at which plant residues decompose and release plant available nutrients. Enzymes are specific toa substrate and have active sites that bind with the substrate to form a temporary complex. The enzymatic reaction releases a product, which can be a nutrient contained in the substrate.

Problems

Absence or suppression of soil enzymes prevents or reduces processes that can affect plant nutrition. Poor enzyme activity (e.g., pesticide degrading enzymes) can result in an accumulation of chemicals that are harmful to the environment; some of these chemicals may furtherinhibit soil enzyme activity.

Improving Enzyme Activity

Organic amendment applications, crop rotation, and cover crops can be used to enhance enzyme activity The positive effect of pasture is associated with the input of animal manure and less soil disturbance.

.Agricultural methods that modify soil pH (e.g., liming) can also change enzyme activity.

2. Eroded soils

Soil erosion is defined as the detachment and transportation of soil mass from one place to another through the action of wind, water in motion or by the beating action of rain drops. Erosion extensively occurs in poorly aggregated soils (low humus) and in a higher percentage of silt and very fine sand. Erosion increases when soil remains bare or without vegetation. In India about 86.9% soil erosion is caused by water and 17.7% soil erosion is caused by wind. Out of the total 173.6 Mha of total

degraded land in India, soil erosion by wind and water accounts for 144.1 Mha (Govt. of India, 1990). The surface soil is taken away by the runoff causing loss of valuable topsoil along with nutrients, both native and applied. In India about 5334 million tones (16.35 tonnes/ha/year) of soil is being eroded annually due to agriculture and associated activities and 29% of the eroded materials are permanently lost into the sea.