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Biological Sickness of Soil

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Introduction

Continuous cultivation of single crop in same piece of land over a long period of time reduces growth, yield and quality of many field crops. Monoculture cropping system builds up soil borne pathogen and parasite populations coupled with a shift in soil microbial community composition. Soil microorganisms are key components of natural and agricultural ecosystems, which contributes to chemical and biological processes including break-down of organic matter, carbon and nitrogen cycles, stabilization of soil aggregates and degradation of environmental pollutants. The composition and abundance of soil microbes are controlled by soil properties (soiltemperature, moisture, aeration and pH), but also by higher plants through rhizo deposition and accumulation of leaf and root debris. In this way, plants promote the development of beneficial microbes such as nitrogen fixing bacteria and mycorrhizal fungi.On contrary, it also favour the spread of soil-borne pathogens, plant parasitic nematodes and deleterious rhizobacteria. The hypothesis that soil sickness is due to the accumulation of pathogens in the soil was proposed after the observation that soil sterilization restores crop productivity in soil. Basically, sickness caused by any microorganisms in the soil to deteriorate its physical, chemical and biological properties is known as biological sickness of soil.

Biological problems in soils

1. SOC and microbial population

Soil organic carbon (SOC) is the main source of energy for soil microorganisms and a trigger for nutrient availability through mineralization. Humus participates in aggregate stability, nutrient and water holding capacity. Organic acids are 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.

A direct effect of poor SOC is reduced microbial biomass activity and nutrient mineralization is due to 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 (pest attack, disease spread, and accumulation of toxic substances).

2. Earthworms

Earthworms play a key role in modifying the physical structure of soils by producing new aggregates and pores which improves soil tilth, aeration, infiltration and drainage. Earthworms produce binding agents which are responsible for the formation of water-stable macro-aggregates. They also improves 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.

Low or absent earthworm population is an indicator of little or no organic residues in the soil. High soil temperature and low soil moisture 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.

3. Soil Respiration

Carbon dioxide (CO_2) release from the soil surface is referred 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.

Reduced soil respiration rates indicate that there is little or no microbial activity in the soil. It may also signify the 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 to feed 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. In such anaerobic environments, denitrification and sulphur volatilization usually occur, contributing to greenhouse gas emissions and acid deposition.

4. Soil Enzymes

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 further inhibit soil enzyme activity.

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Management to control biological sickness

1. **Proper Crop Rotation.**

It isused to overcome biological sickness includes thefollowing practices to overcome soil sickness.

- Deep rooted crops-shallow rooted crops such as cotton, castor, pea-potato, lentil, green gram etc.
- Leguminous crops - non leguminous crops (green gram-wheat)
- Exhaustive crops-restorative crops such as potato, sorghum, sugarcane, castor, black gram and cowpea.
- Grain crops should be followed by foliage crops such as wheat- dhaincha, black gram.
- Long duration crops-short duration crops such as sugarcane-cowpea, black gram, ground nut.
- Heavy irrigation to low irrigation.

2. **Polyculture**

Polyculture, the cultivation of different plant species in the same field is the most effective system to avoid biological sickness. Polyculture does not allow the development of biological sickness because this requires a certain time of monoculture to build-up in soil. Polyculture substantially mimics a natural ecosystems where different plant species coexist in mixed communities.

3. **Removal of soil toxins**

Selective removal of phytotoxic compounds has been proposed as another strategy to alleviate biological sickness. In this regard, activated carbon (AC) has been used because of its strong capacity to absorb organic chemicals including pollutants and allelopathic compounds.

4. **Soil sterilization**

Soil steam sterilization is a farming technique that sterilizes soil with steam in open fields or greenhouses. Pests of plant cultures such as weeds, bacteria, fungi and viruses are killed

5. **Soil Flooding**

Soil flooding overcome soil sickness due to potentially leachate water soluble autotoxic substances and control some soil borne pathogens.