11th Meeting

SOIL AERATION

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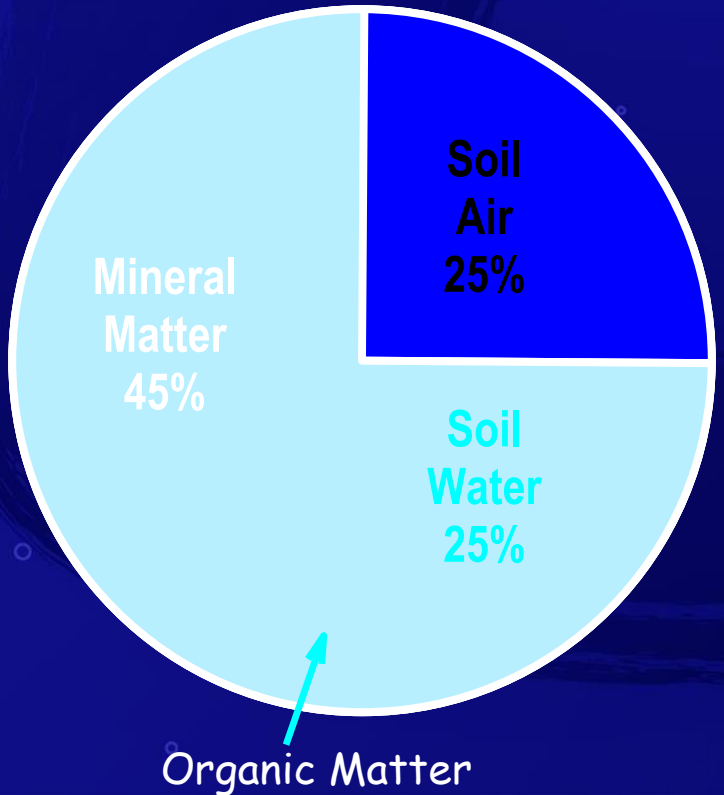
Soil Components
The 4 parts of soil

About ½ of the soil volume is solid particles



About ½ of the soil volume is pore space

PORE SPACE

- Pore space- have a portion of the soil volume not occupied by solid
- It made by :
  - Irregular shapes of primary aggregates and their aggregation
  - Forces of penetrating roots
  - Microorganism
  - Expanding gases entrapped by water
- Pores occupied by water and air

SIZE OF PORE SPACE

Macro pore space	Micro pore space
Diameter > 0.06 mm	Diameter < 0.06 mm
Primaly found between aggregates	Occur within structural aggregates
Allow ready movement of air and perlocating water	•Mostly filled with water in moist soil •Not permit much air movement into/ out of soil and water movement also slow

SIZE OF PORE SPACE

- Soil aeration process is achieved by gaseous exchange
- The more rapidly roots and microbes use up oxygen and release carbon dioxide, the greater is the need for exchange of gases between the soil and the temperature
- Exchange of gases between soil and atmosphere is achieved contents through two mechanism :
    - Mass flow – gas exchange is due to fluctuations in water content of soil that force air in and out
    - Diffusion – gas exchange is by partial pressure

MASS FLOW

- Due to pressure differences between atmosphere and soil air
- Achieved by fluctuation in soil moisture content
- Modified by temperature, wind, barometric pressure
- In case of mass flow the moving forces consist of a total gas pressure and it causes the bulk movement of gas mixture such as air from zone of higher P to a zone of lower P.

DIFFUSION

- More important than mass flow
- Involve great bulk of gaseous exchange
- Each gas moves in a direction determined by its own partial pressure
- Diffusion allows extensive movement of air from one area to another even though there is no overall pressure gradient
- Although diffusion is more important mechanism of soil aeration than mass flow, but in some circumstances mass flow contribute significantly to soil aeration specially at shallow depth and in soil with large pores

SOIL AERATION

- Soil is a continuation of the atmospheric air. It is in constant motion from the soil pores into the atmosphere into the pore space
- The circulation of air in the soil and renewal of component gases like oxygen and carbon dioxide.
- Soil aeration important for :
    - It is used for the respiration by the root
    - Decomposition of the organic matter by microorganisms

COMPOSITION OF SOIL AERATION

- Soil air contains gases like nitrogen, oxygen, carbon dioxide, water vapour and others.
- The composition of soil air is different from atmospheric air
- Composition of soil and atmospheric air

Source	Per cent by volume		
	Nitrogen	Oxygen	Carbon dioxide
Soil air	79.2	20.0	0.35
Atmospheric air	79.0	21.0	0.03

IMPORTANCE OF SOIL AERATION

1. **Soil reactions and properties**
   Microbial breakdown of soil organic residues is reduced under poor aeration and hence organic matter is accumulated. In well aerated soil, aerobic microorganisms are active and they convert simple sugars to CO2 and water using oxygen. In reduced soil, anarobic microorganisms are active and they convert sugars to less CO2 and more methane which is an atmospheric pollutant. This process also gives out some organic acid; ethylene gas, etc. which are toxic to plant roots and some microbes.

IMPORTANCE OF SOIL AERATION

2. **Oxidation and reduction of inorganic elements**
   The oxidized state of nitrogen and sulphur are easily utilized by plants. Reduced forms of some of the elements are toxic. Through solubility of iron and manganese increases, they become toxic to plants. Soil colour is also altered by aeration. Well aerated soils have red, yellow, and reddish brown colours. Reduced soils have grey and blue colours.

IMPORTANCE OF SOIL AERATION

3. **Plant and root growth**

   Soil aeration is important factor for normal growth of plants. Roots absorb oxygen for their respiration and release CO2. The supply of oxygen to roots in adequate quantities and the removal of CO2 from the soil atmosphere are very essential for healthy plant growth. When the supply of oxygen is inadequate, the plant growth either retards or ceases completely as the accumulated CO2 hampers the growth of plant roots. The abnormal effect of insufficient aeration on root development is most noticable on the root crops.

IMPORTANCE OF SOIL AERATION

4. **Microorganism population and activity**

   The microorganisms living in the soil also require oxygen for respiration and metabolism. Some of the important microbial activities such as the decomposition of organic matter, nitrification, etc. depend upon oxygen present in the soil air. The deficiency of oxygen in soil air slows down the rate of microbial activity. The microorganism population is also drastically affected by poor aeration.

IMPORTANCE OF SOIL AERATION

5. **Formation of toxic material**
   Poor aeration results in the development of toxinx and other injurious substances such as ferrous oxide, H_2S gas, CO_2 gas, etc in the soil.

6. **Water and nutrient absorption**
   A deficiency of oxygen has been found to check the nutrient and water absorption by plants. The energy of respiration is utilized in absorption of water and nutrients. Under poor aeration in water logged soils, plants exhibit water and nutrient deficiency.

Measurement of Soil Aeration

A. Oxygen Diffusion Rate (ODR) : The rate at which oxygen in soil is replenished. ODR decreases with soil depth.
B. Oxidation-Reduction (Redox) Potential → Eh
   It indicates the oxidation and reduction states of soil system. In oxidized soil, ferric (Fe^{3+}), Manganic, Nitrate, and suphate ions dominate. In reduced soil, ferrous (fe^{2+}), Manganous (Mn^{2+}), Ammonium, and sulphides are present. The redox potential is denoted by the Eh and measured using platinum electrodes and expressed in millivolts. A positive value indicate oxidized state and a negative value indicate reduced state.

Factors Affecting Soil Air

1. Drainage of water : Amount of macropores
2. Rates of respiration in the soil : O2 and CO2 depens on microbial activity
3. Soil depth (subsoil vs topsoil) : Subsoil usually wetter, higher bulk density, often less total and macropore space, lower OM, and slower respiration.

Factors Affecting Soil Air

4. Changes in a soil condition : caused by tillage (short term introduces air, longterm macropores)
5. Seasonal Differences : Moisture and temperature
    - Humid temperate regions have wet and cold soils
    - More favorable temperature stimulate aeration
6. Vegetation :
    - Remove water by transpiration (can affect depth to water table_
    - Affects soil temperate and therefore respiration rates

Factors Affecting Soil Air

7. Microbial activity : The microorganisms in soil require oxygen for respiration and they take it from the soil air deplete its concentration. Decomposition of organic matter produces CO2 because of increased microbial activity.
8. Soil aeration problems in the field : Under field condition, poor soil aeration occurs due to two conditions: (a) when the moisture content is too high occupying most of the pore space; (b) when the exchange of gases with the atmosphere is slow.

Thank You

Stay safe and healthy..