Lecture 7 & 8, Principle of Soil Science
Second Year Students of Horticulture Department

Assist. Prof. Dr. Tariq Faruq Sadiq

Topic

- **SOIL ORGANIC MATTER AND SOIL ORGANISMS.**
- **SOIL FERTILITY AND PLANT NUTRITION.**
- **SOIL SURVEY AND CLASSIFICATION.**

SOIL ORGANIC MATTER AND SOIL ORGANISMS.

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition).

Most of our productive agricultural soils have between 3 and 6% organic matter.

A typical soil has a biomass composition of

- **70** % microorganisms,
- **22** % macro fauna
- **8** % roots.

Organic matter is made up of different components that can be grouped into three major types:

1. Plant residues and living microbial biomass (**< 15%).**

2. Active soil organic matter also referred to as detritus (**33% - 50%**).

3. Stable soil organic matter, often referred to as humus (**33% - 50%**).

Humus is the dark organic matter that forms in soil when dead plant and animal matter decays.

What are the Components of Humus?

1- Humic acid.
2- Folvic acid.
3- Humin.

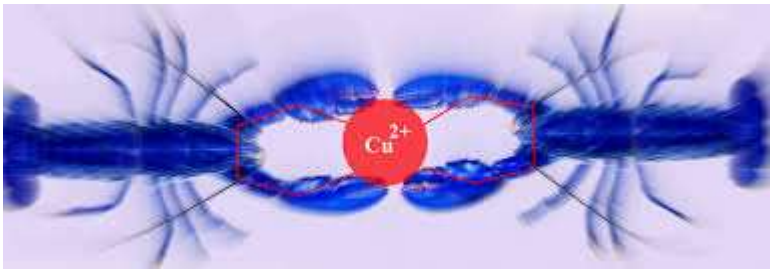
Factors affecting decomposition of humus
1-Temperature
2- Moisture
3- Aeration
4- Micro-organism
Functions of Soil Organic Matter

1. It serves as a source of N, P, K, ets for plant growth.
2. It increases the soil's CEC, due to its high CEC (>300 C molc/Kg soil).

3. OM can serve as chelates for micronutrient metals.
4. It improves soil water content and water availability.
5. Improve physical properties of soil (aggregate stability, soil aeration, reducing runoff).
6. It produces organic acids which dissolve soil mineral.
7. It keeps on soil temperature.
8. It keeps on soil from erosion.
9. Provides food for the living organisms in the soil.
10. Enhances soil microbial biodiversity and activity.

What is Chelates?

- A chelate is an organic compound which combines with and protects certain metallic cations such as Fe, Mn, Cu and Zn etc. Or
- Chelates (meaning 'claw') are soluble organic compounds that bind metals such as copper, iron, manganese, and zinc, and increase their solubility and availability to plants
- It may also bond with minerals such as nitrogen, potassium, or phosphorous.



- The role of chelates is to keep metal cations in solution so they can diffuse through the soil to the root. This is accomplished by the chelate forming a 'ring' around the metal cation that protects the metal from reacting with other inorganic compounds.

What is soil microbiology?

- ✓ Soil microbiology is branch of soil science which deals with the study of organisms in soil, their functions, activities, and how they affect soil properties.
- ✓ Organisms, both animals (fauna/micro-fauna) and plants (flora/micro-flora) are important in the overall quality, fertility and stability of soil.
- ✓ They are responsible for the formation of humus, a product of OM degradation and synthesis.

Soil Organisms Classification

- ✓ **Listing of soil organisms into <u>animal (fauna) and plant (flora)</u>**

1- **<u>Fauna (animal)</u>**
   - **a-** Macro Fauna (Rats, Ants, Earthworm, Shell).
   - **b-** Meso Fauna (Termites, Collembolan, Worms).
   - **c-** Micro Fauna (Nematode, Protozoa).

2- **Flora (plant)**
   a- Macro Flora or Green plants (roots).
   b- Meso Flora (Lichen)
   c- Micro Flora (Alga, Fungi, Bacteria, Actinomycete and Sino-bacteria).

✓ **Listing of soil organisms into Autotrophic and Heterotrophic according to source of energy and carbon.**

1- ***Autotrophic*** **–** obtain energy from sun or mineral; CO_2 from atmosphere for tissue making. Or they can make own food from organic compounds.

2- ***Heterotrophic*** **–** cannot make their own organic compounds, they use organic matter. **Include all fauna and mostly flora except some bacteria (autotrophic)**

Role of organisms in soil, Organisms of the soil play major roles in:

1. Nutrient cycling & release (breakdown of organic compounds)
2. Biochemical weathering of minerals & soil development
3. Ameliorating soil physical & chemical properties

- **Without this living component, the mere (just) accumulation of the mineral fraction would not be "soil".**

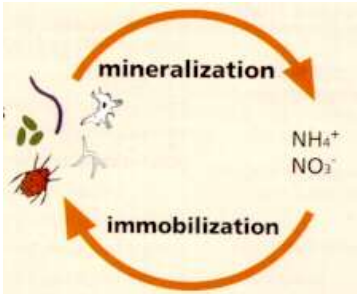
Mineralization and Immobilization

Mineralization is the decomposition or oxidation of the chemical compounds in organic matter releasing the nutrients that may be available to plant.

Immobilization is the conversion of inorganic compounds to organic compounds by micro-organisms or plants.

Soil condition that promotes microbial activity

i. Moist soil (near field capacity)
ii. good aeration
iii. pH near neutral
iv. high nutrient content
v. soil temperature near to 30 ^oC (86 ^oF)



SOIL FERTILITY AND PLANT NUTRITION.

What is Soil Fertility?

Soil Fertility is ability of the soil to provide all the essential plant nutrients in available form and suitable balance.

Nutrient analysis of the soil determines the potential of the soil for supplying N, P, K, Ca, Mg, S, plus micronutrients to plants during the growing season.

Nutrients availability through a number of processes **organic matter decomposition, chemical weathering of minerals, airborne additions, and fertilizers.**

Fertilizer is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients essential to the growth of plants

Fertilizer grade. The numbers on a bag of fertilizer--"10-5-5", these numbers indicate the bag of fertilizer contains: 10% N, 5% P_2O_5, and 5% K_2O.
Fertilizer ratio is the relative proportion of primary nutrients (N-P_2O_5-K_2O) in a fertilizer grade, divided by the highest common divisor; in this example, 10 ÷ 5=2, so the ratio of this fertilizer is 2-1-1.

Supply nutrients to crops. There are two types of fertilizer: -
1- Inorganic fertilizers = mined or synthetically manufactured mineral supplements
2- Organic fertilizers = animal manure, crop residues, compost, etc.

Benefits of chemical (Inorganic commercial) fertilizer

- ✓ Contain major nutrients N, P, K, Ca Mg and sometimes trace elements
- ✓ High nutrient concentration and fast release
- ✓ Compound or mixed type (compound = fertilizer contain single element (Urea (46% N)); mixed fertilizer = fertilizer contain 2 or more elements for example **monoammonium phosphate (11-52-0) or diammonium phosphate (18-46-0)**).
- ✓ Controlled-release: ie. Urea slow release

Problems with inorganic fertilizer

- Water pollution
- Contamination with impurities
- Soil acidification
- Trace mineral depletion
- Over fertilization
- Contribution to climate change.

Benefits of organic fertilizer

- Organic fertilizers have been known to improve biodiversity
- long-term productivity of soil

- increase the abundance of soil organisms by providing organic matter and micronutrients for organisms such as fungal mycorrhiza
- reduce external inputs of pesticides, energy and fertilizer, at the cost of decreased yield.

Disadvantages of organic fertilizers

- Organic fertilizers may contain pathogens and other disease causing organisms if not properly composted.
- Nutrient contents are variable and their release to available forms that the plant can use may not occur at the right plant growth stage
- Heavy metal accumulation
- Persistent organic pollutants

The most important notice about fertilizer application are:

Fertilizer application:

- ❑ Type of fertilizer used
- ✓ Chemical (powder, granular, foliar)
- ✓ Organic
- ❑ Method of application
- ✓ Broadcasting
- ✓ Trend
- ✓ Foliar
- ✓ Fertigation
- ❑ Time of application
- ✓ Growth stage
- ✓ Split application
- ❑ Rate of application

Limiting Factor, the nutrient which is present in the least quantity in the soil is termed a limiting nutrient. The growth and reproduction of plants are controlled by the limiting nutrient availability and concentration.

Fertilizer Problem

Nutrient Analysis - N - P - K = N - P_2O_5 - K_2O

To convert %

P = 0.44 x %P_2O_5 & %K = %K_2O x 0.83

If you apply 25 kg of P_2O_5 the amount of elemental P you applied would be, 25 x 0.44 = 11 kg P

Examples

Fertilizer Bag = 20 - 5 - 10 = 20% N, 5% P_2O_5, 10% K_2O

If you apply 50 kg of the above fertilizer, calculate the elemental content?

0.20 x 50 = 10 kg N,

0.05 x 50 = 2.5 kg P_2O_5 or 1.1 kg of P,

0.1 x 50 = 5 kg K_2O or 4.15 kg K.

If you need 85 kg of N for Corn how many kg of this fertilizer (20-5-10) do you need?

85/0.20 = 425 kg fertilizer
How many kg of elemental K will you apply with the 85 kg of N.
425 x 0.1 = 42.5 kg K_20 or
42.5 x 0.83=35.275 kg K

A 30 kg sack of fertilizer (25 - 5 - 5) , is applied to your garden.

Amount of N applied = 0.25 x 30 = 7.5 kg N
Amount of P_20_5 applied = 0.05 x 30 = 1.5 kg P_20_5
= 0.44 x 1.5 = 0.66 kg P
Amount of K_20 applied = 0.05 x 30 = 1.5 kg K_20
=.83 x 1.5=1.245 kg K

SOIL SURVEY AND CLASSIFICATION.

What is Soil Survey?

Soil Survey is "a systematic examination, description, classification, and mapping of the soils in a given area."

Soil Survey - Inventory of the Soil Resource That Involves 3 Main Elements:

- 1) A **Soil map** showing the geographic relationships of each soil
- 2) **A text** describing the soils
- 3) **Tables** giving physical and chemical data and interpretations for various uses.

Soil Survey – Types

RECONNAISSANCE (observation): coverage large area to identify land having potential for agricultural development.

SEMI-DETAILED: carried out to assist the planning of the proposed land use pattern.

DETAILED carried out for specific purposes such land leveling, irrigation design, general farm planning, and fertilizer recommendations.

Map Scale: Map scale refers to how many inches/cm on the map represents inches/cm on the ground –

- Scale of 1:24,000 says 1 cm on map = 24,000 cm on the ground. Or 1 cm = 240 m or 0.24 km.

SOIL CLASSIFICATION

Soil classification is the separation of soil into classes or groups each having similar characteristics and potentially similar behavior.

There are currently 4 main classification schemes: Russian, FAO, Canadian, and Soil Taxonomy (Euro-American in origin, but used worldwide).

Soil Taxonomy – Purpose

1. Organize knowledge about soils.
2. Understand relationships among different soils
3. Establish groups or classes for practical purposes.
   a) predicting behavior,
   b) identifying best uses,
   c) estimating productivity,
   d) extending research results

Soil Taxonomy

- Soils are divided into six distinct categories based on diagnostic characteristics. **The highest category of this system is called Orders. Currently there are 12 soil orders**

1) Orders (12)
2) Suborders (64)
3) Great Groups (>300)
4) Subgroups (>2,400)
5) Family (>7,000)
6) Series (a lot!)

Diagnostic Characteristics use to classify soils

Diagnostic Characteristics are properties can be used to classify soils such as:

- **soil depth**
- **moisture**
- **temperature**
- **texture**
- **structure**
- **cation exchange capacity**
- **base saturation**
- **clay mineralogy**
- **organic matter content**
- **salt content.**

Orders of Soil Taxonomy: All of the soils in the world can be assigned to one of just 12 soil orders:

1- Alfisols moderately leached soils with a subsurface zone of clay accumulation and >35% base saturation
2- Andisols soils formed in volcanic ash
3-Aridosols deserts $CaCO_3$-containing soils of arid environments with subsurface horizon development
4- Entisols soils with little or no morphological development "young" soils (floodplain ,mountains , desert, etc.
5- Geisols soils with permafrost within 2 m of the surface
6- Histosols Organic soils ,common in wet and cold areas (marshes ,muskeg, etc.)
7-Inceptisols Fairly "young" soils –soils with weakly developed subsurface horizons soil development more advanced than Entisols
8-Molisols grassland soils with high base status. thick, dark surface - humid and sub-humid grasslands
9- Oxisols intensely weathered soils of tropical and subtropical environments very low fertility, very "old" soils
10-Spodosols acid forest soils with a subsurface accumulation of metal-humus Complexes
11- Ultisols strongly leached soils with a subsurface zone of clay accumulation and <35% base saturation
12- Vertisols clayey soils with high shrink/swell capacity.

The dominant soil orders in Iraq and Kurdistan
1- Aridisols (62.2%).
2- Entisols (16.2%).
3- Inceptisols (12.6).
4- Mollisols (3.8%) .
5- Vertisols (1.2%).