Humus – Fractionation of organic matter –

Humus

Humus is a complex and rather resistant mixture of brown or dark brown amorphous and colloidal organic substance that results from microbial decomposition and synthesis and has chemical and physical properties of great significance to soils and plants.

Humus Formation

The humus compounds have resulted from two general types of biochemical reactions: Decomposition and Synthesis.

1. Decomposition:

a) Chemicals in the plant residues are broken down by soil microbes including lignin. b) Other simpler organic compounds that result from the breakdown take part immediately in the second of the humus-forming processes, biochemical synthesis. c) These simpler chemicals are metabolized into new compounds in the body tissue of soil microbes. d) The new compounds are subject to further modification and synthesis as the microbial tissue is subsequently attacked by other soil microbes.

2. Synthesis:

Involve such breakdown products of lignin as the phenols and quinones. a) These monomers undergo polymerization by which polyphenols and polyquinones are formed. b) These high molecular weight compounds interact with N-containing amino compounds and forms a significant component of resistant humus. c) Colloidal clays encourage formation of these polymers. d) Generally two groups of compounds that collectively make up humus, the humic group and the nonhumic group.

Soil organic matter fractions

1. Humic matter
2. Non humic matter

When soil is extracted with alkali the humic substances go into solution. The insoluble portion forms the non humic matter.

Humic group

1. This group makes up about 60-80% of the soil organic matter.
2. They are most complex. They are most resistant to microbial attack.
3. Humic substances have aromatic ring type structures.
4. These include polyphenols and poly quinones.

These are formed by decomposition, synthesis and polymerization. The humic substances are classified based on resistance to degradation and solubility in acids and alkalis into

1. Humic acid
2. Fulvic acid
3. Humin acid

Non humic group

1. This group makes upto 20-30% of the organic matter in soil.

2. These are less complex and less resistant to microbial attack as compared to humic substances.
3. They are polysaccharides, polymers having sugar like structures and polyurondes.
4. These include proteins, carbohydrates, lignins, fats, waxes, resins, tannins and some compounds of low molecular weight.

Theories on humus formation

Lignin theory: Proposed by Waksman (1936). According to this theory humic substances are formed due to the incomplete degradation of lignin

Kononovas theory: According to this theory humic substances are formed by cellulose decomposing mycobacteria earlier to lignin decomposition.

Polyphenol theory: (Flaig and Sochtig (1964)

1. As per this theory the humic substances are formed by the condensation of phenolic materials.
2. The polyphenols of lignin are oxidized to quinones.
3. These quinones are condensed with low molecular weight microbial products to form humic molecules.
4. The microbial products are amino acids, nucleic acid and phospholipids.

Properties of Humus

1. The tiny colloidal particles are composed of C,H, and O_2 .
2. The colloidal particles are negatively charged (-OH, -COOH or phenolic groups), has very high surface area, higher CEC (150 – 300 cmol/kg), 4 - 5 times higher WHC than that of silicate clays.
3. Humus has a very favorable effect on aggregate formation and stability.
4. Impart black colour to soils.
5. Cation exchange reactions are similar to those occurring with silicate clays

Clay – Humus Complex

Humus, the organic amorphous colloid supplies both basic and acidic ions which is transitory and ultimately disappears from soil. Clay, the inorganic crystalline colloid supplies chiefly the basic nutrient ions is more or less stable. Both these colloids form the soil colloidal complex and are extremely active and form important sources of plant nutrients.

It is believed that humus and clay exist in the soil as clay – humus complex, the two being held together by cations like Ca, Fe, etc. Depending upon the nature of binding cation, two types

of Clay – humus complex have been recognized. The colloidal complex bound by Ca ions is more stable and is responsible for the favorable physical condition of the soil, particularly its structure. The other type where Fe acts as the binding agent creates a poor physical condition of the soils.

Maintenance of Humus (Soil organic matter)

1. Maintenance of humus at a higher level is difficult.
2. This is due to the reason that the loss of carbon from the soil increases as the organic matter content is raised.
3. No attempt should be made to increase the organic matter content over that
   The soil plant-climate control mechanism can permit.
4. There is a strong linkage between soil Nitrogen and soil organic matter.
5. To maintain adequate level of organic matter in the soil the N level should be maintained by inclusion of legumes in crop rotation and judicious application of N fertilizers.
6. Loss of N from the soil is also to be minimized.
7. To maintain the organic matter level continuous addition of organic materials is essential.
8. These include animal manure, organic wastes and crop residues.
9. Incorporation of green manure will add to the organic carbon level of soil.
10. Ensuring vigorous crop growth by removing constraints in crop production will result in addition of root and top residues to the soil.
11. Conservation tillage (minimum tillage) should be followed to the extent possible.
12. This will reduce the decay of residues.
13. Keeping the land fallow to encourage natural vegetation is also advisable.