End Semester Examination, 2013

AR-7888

Model Answer

Class: B.Sc. II Sem. (Forestry) **Paper: Forest Soils: Chemistry & Fertility**

1. Which of the soil process is responsible for the development of temperate soils:
Answer (b): Podzolization

2. What is the color of forest Soils?
Answer (a.): Dark Brown

3. Tropical Forest Soil is also known as:
Answer (a.): Laterite Soil

4. What is the total number of beneficial elements for the plant nutrition?
Answer (a.): 04

5. Which of the following is an example of secondary nutrient?
Answer (a.): Ca

6. Which of the following essential element is required in the formation of amino acids, the building blocks of protein?
Answer (d): N

7. Which of the following genera of microorganism is used to evaluate the soil fertility?
Answer (a.): Asperegillus

8. Which of the following soil organism is harmful?
Answer (d): Nematodes

9. Which of the following is a Nitrogen Fixing Organism?
Answer (d): Rhizobium

10. Which of the following is an example of biofertilizer?
Answer (d): Rhizobium

Q. 2. Define forest soil and compare forest soil with cultivated soil.
Answer:

Forest soil is a natural medium that produces nature's most magnificent crop i.e. the forest where an association of plants and animals exist since time immemorial.

Definition: According to-
Agronomists: A mixture of sand, silt, clay, lime and humus.

Geologists: Product of weathering derived from minerals and decomposed remains of plants and animals.

Soil Scientists: Soil is the weathered surface layer of earths which has been altered by the influence of water, air, organic matter, and living organisms.

Nature /lover: Soil is a natural medium for the growth of diverse plants.

All the concepts are well founded but not acceptable to silviculturists interested in soil as medium for plant growth. In many instances forest soil is a product of weathering composed of sand, silt and clay arranged in genetic horizons. Very often forest grow on barren rocks, piles of gravelly detritus, deposits of peat or permanently flooded areas, mangrove forests. These in general disregarded general definitions of soil do not appear as rare exceptions but cover vast areas in different parts of the world and often support forest stands of high commercial value. Obviously the existence of such forest sites demands a broader concept of forest soils and somewhat a different approach to their studies and utilization.

Components of soil: organic matter, mineral matter, water, air, microorganisms and small soil animals.

Comparative study of forest soil with cultivated soil

Cultivated soil:

1. Rich in inorganic materials or mineral materials like quartz, mica feldspar, (Primary) silicate clays and iron oxide (Secondary) charged ions of the elements for plant growth
2. OM is 1-6 %. Examples are agriculture soils, horticulture soils, orchard crops and plantation crops.
3. These soils occupy majority of land, and poor in microbial diversity.

4. Needs rigorous management viz.irrigation, fertilization, weeding soil working manuring and application of agrochemicals.

Forest soil:

1. Rich in organic materials, OM and Humus.
2. OM is 50% by volume and 20% by weight. Examples are forest soils, marshes, bogs and swamp and plantation forests.

3. Organic soils occupy small area of land, rich in microbial diversity like algae, fungi, actinomycetes, bacteria. Supply higher amounts of energy as mineral constituents to microbes.
4. Do not need such rigorous management and inputs.

Q. 3. What do you understand by temperate forest soils? Write down the important characteristics of temperate forest ecosystem soils?

Answer:

Temperate Forest: A Forest ecosystem in which winters are cold and summer rainfall is sufficient to allow enough moisture for trees to grow and shade out grasses with rainfall 75-150cm.

Temperate soils have a thick humus layer and contain lots of organic matter and have a high mineral content. Mostly because of the amount of water is not so high as to oxidize it and not low enough to impede chemical weathering/nutrient release.

Temperate soils accumulate deep vegetation and are clearly banded into the A, B, and C horizons. The soils tend to be darker because the dark minerals have not been dissolved. The ground has a high capacity for water absorption and is nutrient rich.

Characteristics of Temperate Forest Ecosystem soils

Temperate Forests: These have been classified into-

1. Coniferous
2. Evergreen
3. Deciduous
4. Rain

Characteristics:

1. These are found in Northern Hemisphere, Tundra, Canada, Europe and Asia (Taiga forest), Coniferous high altitude and Broad leaved at lower altitudes (mixed).
2. Soils are moist.
3. Low in Nitrogen and essential bases.
4. Highly Leached soils.
5. Nature of soil or humus is acidic.
6. Podzolization is responsible for the soil formation.
7. The oxides of iron and aluminum are removed from upper horizons and as a result the soil texture becomes sandy and color becomes light grey.
8. These oxides are deposited in lower horizons of the soil profile.
9. These Temperate soils are classified as Mollisols, Vertisols, Inceptisols, and Altisols.
10. Water table is high.
11. Temperate Rain Forests soils are well supplied with OM, having a moderate layer of clay.
12. The principal forest species groups in temperate forests include: pines; oaks; beeches; and eucalyptus.

13. Temperate forests are home to a wide variety of animals. These animals include various insects and spiders, wolves, foxes, bears, coyotes, bobcats, mountain lions, eagles, rabbits, deer, skunks, squirrels, racoons, squirrels, moose and hummingbirds.

Q. 4. What do you mean by essential elements and their sources? Give the names of essential elements and write down the functions of N, P, & K elements?

Answer:

Plants require various types of elements for their growth, reproduction and metabolism. These elements are called mineral elements. Plants obtain these mineral nutrients from soil with the help of roots. The uptake and utilization of various plant nutrients in the form of ions from soil is called the mineral nutrition.

There are about 17 essential elements required for growth and development of plants. These are: carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg), boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn).

Sources: Carbon: Water, Air and Soil.
Hydrogen: Water and Air.
Oxygen: Air and water
All Other: Soil.

Functions:

a. Nitrogen:

1. Necessary for formation of amino acids, building blocks of protein.
2. Essential for plant cell division, vital for plant growth.
3. Directly involved in photosynthesis.
4. Necessary component of vitamins.
5. Aids in production and use of carbohydrates.
6. Affects energy reactions in plant.

b. Phosphorus:

1. Involved in photosynthesis, respiration, energy storage and transfer, cell division and enlargement.
2. Promotes early root formation and growth.
3. Improves quality of fruits, vegetables and grains.
4. Vital to seed formation.
5. Helps plant survive harsh winter conditions.
6. Increases water use efficiency.
7. Hastens maturity.

c. Potassium:

1. Carbohydrate metabolism and break down and translocation of starches.
2. Increases photosynthesis.

3. Increase water use efficiency.
4. Essential to protein synthesis.
5. Important in fruit formation.
6. Activates enzymes and controls their reaction rates.
7. Improves quality of seeds and fruit.
8. Improves winter hardiness.
9. Increases disease resistance.

Q. 5. What are the common nutrient deficiency symptoms seen in growing plants? Describe the deficiency symptoms of N, P, K, elements?

Answer:

Some common deficiency symptoms caused by nutrient deficiencies in growing plants are generally categorized as:

1. **Burning:** severe localized yellowing; scorched appearance.

2. **Chlorosis**: general yellowing of the plant tissue; lack of chlorophyll.

3. **Generalized:** symptoms not limited to one area of a plant, but rather spread over the entire plant.

4. **Immobile**: not able to be moved from one part of the plant to another.

5. **Interveinal Chlorosis**: yellowing in between leaf veins, yet veins remain green.

6. **Localized:** symptoms limited to one leaf or one section of the leaf or plant.

7. **Mobile**: able to be moved from one plant part to another.

8. **Mottling:** spotted, irregular, inconsistent pattern.

9. **Necrosis:** death of plant tissue; tissue browns and dies.

10. **Stunting**: decreased growth; shorter height of the affected plants.

Deficiency Symptoms:

a. Nitrogen (N):

1. Old leaves turn pale green and may eventually yellow.
2. New leaves paler green than existing leaves and appear to be smaller than normal.
3. Plant growth slows down.
4. Under side of leaves may become red or purple.
5. Wilting easily under normal weather.

b. **Phosphorus (P):**

1. Small thin stalks.
2. Stunted growth.
3. Purple Veins.
4. Older leaves may appear bluish green.
5. Reduced blooms and onset of fruits.

c. **Potassium(K):**

1. Brown scorching and curling of leaf tip.
2. Chlorosis between leaf veins.
3. Purple spots on underside of leaf.
4. Plant growth, root development, seed and fruit development are reduced.
5. Symptom first appears in older leaves.
6. Deficient plant may become prone to frost damage and diseases.

Q. 6. Describe the following:
a. Three criteria of essential elements and functions of N, P, K.
b. Soil fertility evaluation.

Answer:

According to the Arnon and Stout, 1939 the criteria for essentiality mineral elements are as follows-

1. The plant is unable to grow normally and cannot complete its lifecycle in the absence of elements.
2. The element is specific and cannot be replaced by another element, however, close it may be in the periodic table.
3. The element plays a direct role in the metabolism of the plant.

Functions of N:

1. Necessary for formation of amino acids, the building blocks of proteins.
2. Essential for plant cell division, vital for plant growth.
3. Directly involved in photosynthesis.
4. Necessary component of vitamins.
5. Aids in production and use of carbohydrates.
6. Affects energy reactions in the plant.

Functions of P:

1. Involved in photosynthesis, respiration, energy storage and transfer, cell division and enlargement.
2. Promotes early root formation and growth.
3. Improves quality of fruits, vegetables, and grains.
4. Vital to seed formation.
5. Helps plants to survive harsh winter conditions.

6. Increase water use efficiency.
7. Hastens maturity.

Functions of K:

1. Carbohydrate metabolism and break down translocation of starches.
2. Increases photosynthesis.
3. Increase water use efficiency.
4. Essential to protein synthesis.
5. Important in fruit formation.
6. Activates enzymes and controls their reaction rates.
7. Improves quality of seeds and fruits.
8. Improves winter hardiness.
9. Increases disease resistance.

b. Soil fertility evaluation:

Soil fertility is the over all ability of soil to support vigorous growth of crops by ensuring adequate supply of water and creating favorable conditions for nutrient uptake and root growth.

Soil fertility evaluation is a central feature of modern soil fertility management. The fundamental purpose of the soil fertility evaluation is to quantify the ability of soils to supply the nutrients required for optimum plant growth.

Factors affecting soil fertility:

Over 50 factors affect soil fertility. These have been majorly divided into:

1. Climatic factors.
2. Soil factors
3. Crop factors

Techniques to assess soil fertility:

Several techniques are commonly employed to assess the fertility status of soil. These are:

1. Nutrient deficiency symptoms of plants.
2. Analysis of tissue from plants growing on the soil.
3. Biological tests in which the growth of either higher plants or certain microorganisms is used as a measure of soil fertility.
4. Soil analysis.

Nutrient deficiency symptoms of plants:

Careful inspection of the growing plant can help identifying a specifying nutrient stress. If a plant is lacking in a particular nutrient, characteristic symptoms may appear. Nutrient deficiency symptoms may be classified as:

1. Complete crop failure at the seedling stage.
2. Severe stunting of plants.
3. Specific leaf symptoms appearing at varying times during the season.
4. Internal abnormalities such as clogged conducting tissues.
5. Delayed and abnormal maturity.

6. Obvious yield differences, with or without leaf symptoms.
7. Poor quality of crops including differences in protein, oil, or starch content and storage quality.
8. Yield differences detected only by careful experiment work.

In addition nutrient deficiency has a marked effect on extent of type of root growth. Inspection of root growth can be an important diagnostic tool to assess soil fertility.

Hidden Hunger: Hidden hunger refers to the situation in which crop needs more of a given nutrient yet has shown no deficiency symptoms. The nutrient content is above the deficiency symptptom zone but sill considers below that needed for optimum crop production. Hidden hunger can be eliminated by:

1. Testing of plants
2. Testing of soils.
3. Past management practices.

Plant Analysis:
Tissue test and plant analysis are made for the following reasons;

1. To aid in determining the nutrient supplying power of soil.
2. To help identify deficiency symptoms and to determine nutrient storages before they appear as symptoms.
3. To aid in determining the effect of fertility treatment on the nutrient supply in the plant.
4. Top study the relationship between the nutriuent status of the crop and plant performance.

Tissue test: This is important to diagnose the nutrient need of growing plants.

Method: Plant parts may be chopped up and extracted with reagents. The intensity of color developed is compared with standards band used as measure of the supply of plant nutrients.

Critical nutrient concentration (CNC):
It is commonly used in interpreting plant analysis results and diagnosing nutritional problems. CNC is the level of nutrient below which crop yield, quality or performance is unsatisfactory.
CNC is defined as the range of nutrient concentration at a specified growth above which the crop is amply supplied and below which the crop is deficient.

Biological Tests:
1. **Laboratory and green house tests:**
Small quantity of soil is collected to quantify the nutrient supplying power of of soil.
2. Microbial Test:
Growth of Azatobacter or Aspergillus niger reflets nutrient deficiency in the soil. The soil is rated from very deficient in the respective elements depending on the amount of colony growth. Microbiological methods are rapid simple and require little space.
Objectives of Soil Tests

1. To provide an index of nutrient availability or supply in a given soil.
2. To predict the probability of obtaining a profitable response to lime and fertilizer.
3. To provide a basis for recommendation on the amount of lime and fertilizer to apply.
4. To evaluate the fertility status of soils on a country soil, area or state wide basis as the case of soil test summaries.

Q. 7. What are the various groups of soil organisms? Describe the functions of algae, fungi, bacteria, actinomycetes, and protozoa in soil ecosystem?

Answer:
Soil organisms can be grouped in the following headings:
1. Anamalia
2. Plantae
3. Fungi
4. Protista
5. Monera
6. Soil Viruses

1. Anamalia:
This group includes a range of soil animals starting from large size burrowing animals and down to the mites.

   a. Burrowing animals
   b. Earthworms
   c. Arthropods and gastropods
   d. Nematodes

Burrowing animals: Large burrowing animals such as moles, mice, shrews, rabbit, badgers, and wood chuks aerate the soil and alter the fertility and structure, but they eat and destroy vegetation also which make them more detrimental than beneficial.

Earthworms: these are important soil organisms much appreciated by Fishermen, Gardners, and Agronomists.Earfthworms belongs to the Phylum Anelida and about 700 species have been identified. Earth worms prefer moist, well aerated, warm soils with pH between 5.0 and 8.4 with plenty of organic matter with low salt concentrations.

Arthropods and gastropods: Arthopods are joint-footed invertebrates and includes mites, millipedes, centipedes, and insects. They feed mostly on decaying vegetation and help to aerate the soil with their burrows.
Gastropods include slugs and snails, these are the belly footed organisms, feed on decaying vegetation but also eat and damage the living plants.

Nematodes: Nematodes are microscopic, unsegmented, thread like worms .They are classified according to their different feeding habits like- omnivorous, predaceous and parasitic nematodes.

2. Plantae:
The plantae organisms obtain energy from sun and can exist as stationary life. Plantae are classified as;
1. Macro plantae, possess tap and fibrous root system.
2. Microplantae, no root system exists, is classified into algae, fungi and lichen.
3. **Algae:**
   Soil algae are microscopic, chlorophyll bearing organisms. The various groups of algae are:
      Green algae
      Yellow algae
      Diatoms

Functions:

1. Algal growth in soils can produce considerable amount of organic material, hundreds of Kgs per hectare annually.
2. The algae fix the Nitrogen and the fungi attach to the surface and form a protective mat that holds water and supplies other nutrients to the algae.
3. Lichens are also produced from an association of fungi and algae.

4. Fungi:

Fungi are organisms without the ability to use the sun for energy; they live on dead or living plant or animal tissues. Fungi are one celled organism or multicellulear, have been classified in four major groups:

Phycomycetes
Ascomycetes
Basidomycetes
Deuteromycetes

Functions:

1. Fungi act as organic matter decomposers.
2. They are vigorous decomposers of cellulose, lignin, gum, and other complex compounds.
3. Fungi also secrete substances that aid in the formation of water stable soil aggregates.
4. Fungi form an important symbiotic association with the root of higher plants, known as Mycorrhizae.

5. Protista:

Protozoa is the main phyla of Protiosta kingdom. A protozoa is a unicellular organism without the true cell wall. Protozoa ingest bacteria, fungi, nematodes, larva, eggs and even smaller protozoa. Three types of Protozoa are found,

1. Amoeboid
2. Flagella
3. Ciliate

Functions:

1. They help to control other microbes but also cause critical diseases.
2. Protozoan digestion of bacteria and fungi influences microbial population and thus hastens the recycling of plant nutrients.

6. Monera (Bacteria & actinomycetes):

The microorganisms, bacteria and actinomycetes belong to the Monera Kingdom.

a. Soil Bacteria are unicellulkar microorganisms without chlorophyll which usually multiplies by binary fission. Soil Bacteria has two types;

1. Symbiotic bacteria
2. Non Symbiotic Bacteria

These both help in the nitrogen fixation of plants and enchance the the soil health.

b. Actinomycetes:

Actinomycetes are taxonomically and morphologically related to both fungi and bacteria but are usually classified with bacteria.These are characterized by branched mycelia, similar to fungi. When mycelia break into short fragments they look like bacteria.

Functions:

1. Take part in decomposition of organic matter, especially cellulose and other resistant organic molecules.
2. They also aid in the development of water stable soil structure by secreting non water soluble gummy substances.

Q. 8. Write short notes on the following:
a. Rhizosphere and Phyllosphere
b. Biological Nitrogen Fixation

Answer:

Rhizosphere:
The specialized region of soil around the root which is influenced by root exudates is known as Rhizosphere. The term Rhizosphere was coined long back by Hiltner, 1904 and he defied the zone of enhanced microbial development around roots as the Rhiozosphere. The rhizosphere region is very narrow in width and varies from plant to plant. Depending on the age of plant, the nature of root exudates differs and as a result the rhizosphere effects also vary. The rhizosphere effect has been measured in many plants. Besides the the metabolic state of the plant and the nature of the soil also affect the distance. However, it is generally been noticed that the poorer the soil the more pronounced the rhizosphere effect.

Phyllosphere:
The **phyllosphere** is a term used in microbiology to refer to leaf surfaces or total above-ground surfaces of a plant as a habitat for microorganisms. The below-ground microbial habitats (i.e. the thin-volume of soil surrounding root or subterranean stem surfaces) are referred to as the rhizosphere and laimosphere, respectively. All plants are host to a numerous and diverse community of microorganisms including bacteria, fungi, and yeasts. Some are beneficial to the plant; others function as plant pathogens and may damage the host plant or even kill it. However, the majority of bacterial colonists on any given plant have no detectable effect on plant growth or function.

b. Biological Nitrogen Fixation (BNF), discovered by Beijerinck in 1901 (Beijerinck 1901), is carried out by a specialized group of prokaryotes. These organisms utilize the enzyme nitrogenase to catalyze the conversion of atmospheric nitrogen (N_2) to ammonia (NH_3). Plants can readily assimilate NH_3 to produce the afore mentioned nitrogenous biomolecules. These prokaryotes include aquatic organisms, such as cyanobacteria, free-living soil bacteria, such as *Azotobacter*, bacteria that form associative relationships with plants, such as *Azospirillum*, and most importantly, bacteria, such as *Rhizobium* and *Bradyrhizobium*, that form symbioses with legumes and other plants.

Fixation of Nitrogen:

1. Nitrogen Fixation by Free-Living Heterotrophs/Non-NF:

Many heterotrophic bacteria live in the soil and fix significant levels of nitrogen without the direct interaction with other organisms. Examples of this type of nitrogen-fixing bacteria include species of *Azotobacter*, *Bacillus*, *Clostridium*, and *Klebsiella.*

2. Associative Nitrogen Fixation

Species of *Azospirillum* are able to form close associations with several members of the *Poaceae* (grasses), including agronomically important cereal crops, such as rice, wheat, corn, oats, and barley. These bacteria fix appreciable amounts of nitrogen within the rhizosphere of the host plants.

3. Symbiotic Nitrogen Fixation

Many microorganisms fix nitrogen symbiotically by partnering with a host plant. The plant provides sugars from photosynthesis that are utilized by the nitrogen-fixing microorganism for the energy it needs for nitrogen fixation. In exchange for these carbon sources, the microbe provides fixed nitrogen to the host plant for its growth.

4. Legume Nodule Formation

The *Rhizobium* or *Bradyrhizobium* bacteria colonize the host plant's root system and cause the roots to form nodules to house the bacteria. The bacteria then begin to fix the nitrogen required by the plant.

Frankia actinomyctes form nodules in woody non-leguminous forest trees (*Alnus, Casuariana, Hippophate, Myrica, Eleagnus* species) to fix the atmospheric nitrogen.