Unit 5

Soil Management and Field Preparation

Introduction

The word 'soil' has been used as a synonym with 'land' in Veda, Upanishada and other ancient Indian literature as early as 5000 BC. Great civilisations had fertile soils as one of the most important natural resources. However, destruction or mismanagement of soil has led to the downfall of such civilisations. Soil is a natural body, where plants grow. Healthy soil produces healthy crops.

Soil has different meanings to different individuals. For a farmer, soil is that surface layer of the Earth, which can be ploughed to raise crops for food, fibre and fodder for family and farm animals. For a civil engineer, soil provides foundation for the construction of buildings, roads, highways, etc. Soil health is important for sustainable crop production, and existence of flora and fauna. Exploitation, destruction and mismanagement of soil can lead to extinction of various plants and animals, including humans. Efforts must be made for the maintenance of soil health, which is important for the sustenance of life on Earth.

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Session 1: Soil and Its Properties

Soil

The word 'soil' is derived from the Latin word *solum*. Soil is formed from weathered material of parental rocks. It contains minerals, organic matter, water and air in various proportions. These elements serve as nutrients to plants. Hence, soil serves as a medium for growing plants.

Definition

Soil may be defined as a dynamic natural body developed as a result of pedogenic processes that take place during and after the weathering of rocks, in which plants and other forms of life grow. Joffe (1949) defined soil as a natural body, consisting of minerals and organic constituents differentiated into horizons of variable depths, which differ from the material below in morphology, physical make-up, chemical properties and composition, and biological characteristics. It is, therefore, the upper loose layer of the earth crust, which is rich in nutrients and minerals on which plants grow and depend on for nourishment.

Soil genesis

Transformation of rocks into agricultural land is called 'soil formation' or 'soil genesis'. Weathered material of rocks further undergoes changes and results in the formation of agricultural land. It is a slow process. Five factors are responsible for soil genesis — climate, parent material, topography, plants and animals, life and time.

On an average, soil composition consists of minerals (45 per cent), organic matter (5 per cent), water and air, which are interchangeable (20–25 per cent each). Besides, a number of organisms thrive in soil. The organisms that thrive in soil include rodents, worms, insects, snails, snakes and microorganisms, such as fungi, bacteria, actinomycetes, algae, etc.

Importance of soil

- Soil provides essential nutrients to plants for growth and development.
- It supports the growing plants by firmly holding their roots.
- It holds moisture and water for long time.
- It serves as a habitat for a number of organisms, including microorganisms.
- It provides heat, air and water to organisms growing in or over it.
- It is the most important natural resource of a country.

Soil properties

Soil can be identified or classified according to various characteristics exhibited by it. The properties of soil are helpful in understanding the nature and kind of the soil. The properties of soil can be categorised as physical, chemical and biological.

Physical properties

Soil colour

Soil surfaces, generally, show black, yellow, red and gray hues. The colour of the soil is due to the parent rock, organic matter and minerals present in it. The colour of the upper layers of the soil may be different from its other layers. The colour of the soil is an indicator of the organic matter present in it, soil fertility, soil pH, drainage, aeration and organisms living in it. Munsell soil colour chart gives the values of degree, intensity and purity of soil colour.

Soil texture

It refers to the proportion of different size of particles (sand, silt and clay) that comprise soil. Soil, according to the particle size, can be classified as sandy, silty, loamy and clayey. Big size particles present in the soil are known as 'sand'. The diameter of sand particles is 0.2–2 mm. When the size of soil particles is between 0.2 and 0.002 mm, it is called 'silt'. Clay is the finest particle,

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having a diameter of less than 0.002 mm. Loamy and clayey soils have adequate water-holding capacity and are more suitable for the cultivation of crops.

Porosity

Particles of different sizes are present in soil. When soil particles aggregate, some hollow spaces are formed between them. These inter-particle spaces in the soil are called 'pores', which help carry air and water to plants and other organisms growing in and over it. The quantity and size of pores show the 'porosity' of soil. Soil having big and large number of pores is called 'porous soil'. Such soil has adequate drainage and aeration capacity. Soil having small but more number of pores shows better water-holding capacity. Soil with small and less number of pores is called 'non-porous' soil. Such soil is water stagnant and is not suitable for cultivation.

$$\%\ \text{Pore space} = 100 - \frac{\text{Bulk density}}{\text{Particle density}} \times 100$$

Soil density

Soil consists of various particles. It has certain percentage of pore space through which air and water movement takes place. The density of soil denotes the weight of the soil per unit volume. It is of two types — particle density and bulk density.

Particle density: Particle density refers to the actual density of soil solids. It is defined as mass per unit volume of soil solid only. Particle density of soil gets decreased with increase in organic matter content of the soil. Mostly soils have particle density of about 2.65 g/cm^3.

Bulk density: It refers to weight per unit volume occupied by soil solids, as well as, pore space of the soil. It is expressed as grams per cubic centimetre (g/cm^3). Soils having low bulk densities have better physical conditions.

Soil consistency

Soil consistency is the potential of soil to change the shape or moulding when moist. It also ensures the resistance of soil particles to crushing or pulverising action by implements when dry. Soil consistency helps in knowing the tilth. Knowledge about soil consistency is necessary to understand the soil texture in order to perform tillage operations.

Soil structure

Soil structure denotes varying shapes and arrangements of particles (sand, silt and clay) to form lumps or aggregates. Soil structure may be columnar, prismatic, blocky, platy laminar, granular or crumb. Soil structure can be modified by various soil management practices, such as tillage, manuring, liming, crop rotation, irrigation, etc.

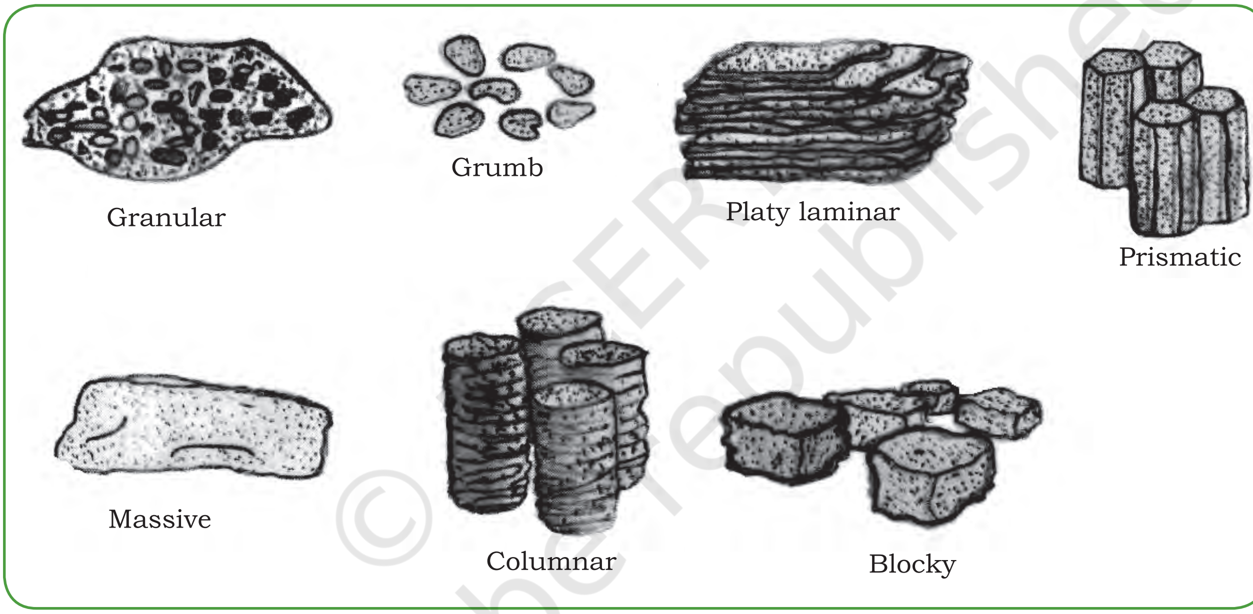

Fig. 5.1: Types of soil structure

Soil temperature

Soil temperature is regulated by the Sun and helps in the decomposition of organic material present in it. Various factors, such as colour, slope, moisture level and vegetation on the soil affect the soil temperature. Low, as well as, high soil temperature is harmful for crops. The growth of crops slows down as the temperature falls below 9 ºC and ceases when it reaches 50 ºC. Microorganisms present in the soil are active when the temperature is 27–32 ºC.

Chemical properties

Chemical properties determine the fertility of soil. These are related to the ability of the soil to supply nutrients to plants growing on or under it. Chemical properties of soil depend on the chemical composition of soil particles. Chemical properties can be exhibited by soil pH, buffering capacity, electrical conductivity, nutrients released, cation exchange capacity, etc.

Soil pH or acidity of soil

Soil pH shows the potentiality of H^+ ions. It determines acidic or alkaline reaction of the soil. More hydrogen ion (H^+) concentration shows the acidic nature of soil, while the concentration of more hydroxyl (OH^-) ions represents its alkaline nature. Neutral condition is produced by an equal concentration of H^+ and OH^- ions. Slightly acidic soils are more suitable for plant growth. Maximum nutrients are available to crops when the pH ranges from 6.5 to 7. Soil pH can be measured by pH meter, pH paper method or pH scale. pH scale has a range of 0–14 with 7 as the neutral point, which indicates the equal concentration of H^+ and OH^- ions. As the value decreases, it indicates higher concentration of H^+ ions. Soils with minimum pH are more acidic in nature. Similarly, as the pH goes above 7, the alkaline reaction of the soil increases with the concentration of OH^- ions.

Some of the effects of soil pH on plant growth are:

- In general, soil pH of 6.5 to 7.5 is considered optimum for maximum availability of plant nutrients.
- Low pH (<6.0) results in an increase in aluminium content in the soil. Its excess may be toxic to plants.
- In general, the availability of toxic metals is more in acidic soils. This affects the activity of soil microorganisms.

Buffering capacity of soil

The capacity of soil that resists sudden change in its pH is called the 'buffering capacity' of soil. Change in pH may affect nutritional balance in the soil, as well as, microbial activities in it. Carbonates, bicarbonates and phosphates act as buffering agents in soil. The buffering capacity of the soil also depends on clay and organic matter present in it.

Soil colloids

Soil colloids may be clay or humus. Clay found in soil is known as 'inorganic colloid', while humus is called 'organic colloid'. Soil colloids that are charged with negative ions (anions) will attract positively charged ions (cations). Cations are held by soil colloids. Cations with lower valency are replaced with ones having higher valency. For example, Na^+ in alkali soils are replaced by Ca^+ after the addition of gypsum. Cation Exchange Capacity (CEC) of the soil is higher if it has more clay and humus content. CEC is denoted in Cmol $kg^{-1}$of soil.

Cation Exchange Capacity (CEC)

It is a measure of the potential of a soil to hold cation nutrients, such as potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+) aluminium (Al^3+), iron (Fe^{2+}), manganese (Mn^{2+}), zinc (Zn^{2+}), hydrogen (H^+) and copper (Cu^{2+}). In simple words, CEC is the measure of the quantity of cations that can be adsorbed and held by the soil. Highly fertile soils, containing high organic matter, have more cation exchange capacity. Soil fertility increases with an increase in cation exchange capacity.

Biological properties

Different type of organisms and microorganisms thrive in soil. Mice, crabs, snails, earthworms, mites, millipedes, centipedes, fungi, bacteria, actinomycetes, protozoa and nematodes are commonly found in soil. They feed on plant residues. These organisms make channels and burrows in the soil, thereby, increasing aeration and enhancing the percolation of water due to their activities. Their excreta adds to the organic matter of the soil. Bacteria predominate neutral soils, while fungi are more in acidic soils. Moist and shady soils favour the growth of algae.

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Soils of India

The soils of India can be classified into different groups, such as black, red, laterite, alluvial, saline, desert, alkaline, forest, hilly, and peaty and marshy.

Black soil

It is dark grey to black in colour and ranges from fertile to poor. The soil is rich in clay (montmorillonite) particles and has neutral to slightly alkaline reaction. The soil is rich in bases, lime and calcium. The pH of black soil is 7.2–8.5. The soil is deficient in nitrogen, phosphate and organic matter but rich in potash, calcium and magnesium. It is soft when wet but forms hard blocks when dry and develops deep cracks. Black soil ranges from heavy clay (ill-drained) to loams (well-drained). Black soil is predominant in Maharashtra, Madhya Pradesh, western Andhra Pradesh, southern Tamil Nadu and northern Karnataka.

Red soil

Such soil results from weathered material of metamorphic rocks. It is porous and friable neutral to acidic in reaction. Nitrogen, phosphate, lime and humus content are very low in this soil. It is found in parts of Tamil Nadu, Karnataka, north-east Andhra Pradesh, eastern parts of Madhya Pradesh, Bihar, West Bengal and Rajasthan.

Lateritic (laterite) soil

Laterite soil is formed in areas receiving high rainfall with alternating wet and dry spells. This soil is red to reddish-yellow in colour. Heavy rains cause leaching of bases and silica from the surface of the soil. The soil shows acidic character with pH of 5–6 and is poor in nitrogen, phosphorus, potash, magnesium and lime. Such soil is porous and well-drained with poor water-holding capacity. The soil is found in eastern Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Odisha, Assam and Ratnagiri district of Maharashtra.

Alluvial soil

Alluvial soil is ideal for horticultural crops. Such soil is found along rivers. It consists of material deposited by rivers during flood. The soil is productive but may be deficient in nitrogen, phosphorus and humus. The soil greatly differs in colour, texture, drainage, presence or absence of sodium salts, etc. It is suitable for the cultivation of vegetables, flowers and fruits. The soil is found in all States of India along the rivers. The Indo-Gangetic soil is the best example of alluvial soil in India.

Desert soil

Desert soil is sandy soil and is found in low rainfall areas. Such soil is alkaline in nature with high pH value and is unproductive. It is rich in soluble salts, and poor in nitrogen and organic matter content. The physical conditions of the soil are unfavourable as it has low water-holding capacity due to high sand content. Desert soil is found in parts of Rajasthan.

Forest and hilly soils

These are shallow soils of higher and lower elevation on the hills. These are stony and infertile for the production of crops. These are low in bases and slightly acidic in reaction.

Saline and alkaline soils

Saline soil shows white incrustation of salts (chlorides and sulphates of sodium, calcium and magnesium) on surface due to high evaporation during summers. It is also called 'white alkali soil'. Such soil is, generally, infertile and poor in drainage. Such soil is formed as a result of saline irrigation water and over-irrigation for a long time, which raises the water table of the soil. Alkaline soil is rich in carbonates and bicarbonates of sodium and is non-porous. It is also called 'black alkali' or '*Usar*' soil. Uttar Pradesh, Punjab, Haryana, Rajasthan, Kerala, coastal Odisha and Sunderban region of West Bengal contain large patches of such soils.

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Peaty and marshy soil

This soil is highly acidic in nature and black in colour. Excessive wetness of the soil causes decay and degradation of dead vegetation, forming a layer of partially decomposed organic matter, resulting into peaty and marshy soil. Such type of soil is, generally, found in States like Tamil Nadu, parts of Bihar and Uttar Pradesh.

Practical Exercise

Activity

Identify the types of soil available in your area and grow some ornamental plants in them.

Material required: Different types of soil, tags, pots and ornamental plants

Procedure

- Collect different types of soil like sandy, silty, sandy loam and clayey available in your area.
- Identify the soil as per their texture and structure.
- Fill the pots with different types of soil.
- Plant ornamental plants in the pots and water them.
- Observe the water requirement and growth of the plants in different types of soil.

Check Your Progress

A. Fill in the Blanks

1. Soil is composed of ________ per cent minerals.
2. The size of the particles between 0.2 and 0.02 mm is known as __________________.
3. The unit of bulk density is ___________.
4. pH determines ____________ or __________ reaction of the soil.
5. Soil fertility _______________ with an increase in CEC.

B. Multiple Choice Questions

1. Humus is ____________________.

   (a) organic colloid (b) inorganic colloid

   (c) chemical (d) fertiliser

2. Black soil has ________________.
   (a) neutral to acidic reaction
   (b) neutral to alkaline reaction
   (c) saline alkaline
   (d) None of the above
3. Red soil results from the weathered material of ________________.
   (a) igneous rock (b) sedimentary rock
   (c) limestone (d) metamorphic rock
4. The soil ideal for horticultural crop production is ______________.
   (a) black (b) red
   (c) alluvial (d) laterite
5. The factor that determines the ability of soil to change the shape or moulding when wet is known as ________________.
   (a) soil consistency (b) soil pH
   (c) soil porosity (d) soil density

C. Subjective Questions

1. What is soil? Describe its physical properties.
2. Describe the types of soil found in India.
3. Write a short note on the following:
   (i) Soil pH
   (ii) Soil salinity
   (iii) Biological properties of soil

D. Match the Columns

A	B
1. Soil texture	(a) Ideal for horticultural crops
2. Clay	(b) Acidic soil
3. Low pH	(c) Finest soil particle
4. Soil	(d) Size of soil particles
5. Alluvial soil	(e) Holds roots and provides nutrition to plants
6. Saline soil	(f) Highly acidic and black in colour
7. Peaty and marshy soil	(g) High salt content

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SESSION 2: SOIL RECLAMATION OR IMPROVEMENT

Soils that are more acidic, alkaline or saline in nature are not desirable for cultivation of crops. Such soils do not favour desirable nutrient supply to plants or support beneficial activities of microbes. Extreme agro-climatic conditions affect the physical, chemical and biological properties of such soils, and create an unfavourable environment within. Acidic soils are mostly found in areas receiving high rainfall, which causes leaching of bases or salts. Saline and alkaline soils are mostly found in arid and dry regions, where the rate of evaporation is high. Soluble salts from the lower layer of the soil come up and get accumulated due to the evaporation of moisture. These soils are not suitable for most crops as the crop yield is poor.

Causes of acidic soil

- Soils developed from acidic rocks like granite are acidic in nature.
- Heavy rains or irrigation leach down bases and lime deep within the soil, thereby, increasing soil acidity.
- Application of Ammonium sulphate and Ammonium chloride as fertilisers also causes increase in soil acidity.
- The decomposition of organic matter, present in the soil, by various microorganisms results in the production of organic acids, which may also increase soil acidity.

Effects of soil acidity on plants

- Soil acidity has a toxic effect on root tissues.
- It affects the permeability of cations from plant membranes.
- Soil acidity also changes the ratio between basic and acidic components within plants.
- It adversely affects beneficial soil microorganisms.
- Aluminium, manganese and iron are highly soluble in acid medium, and thus, become toxic.

- Soil acidity lowers calcium and potassium content in the soil.
- The availability of phosphorus, copper and zinc in the soil is affected due to soil acidity.
- Plant diseases are also more prevalent in acidic soils.

Correction of soil acidity

Soil acidity can be corrected by liming. Lime is applied into soil at the time of land preparation or in ploughed land. About 1,500 kg lime per hectare is required to raise the pH of the soil by one unit. Limestone, burnt lime or slaked lime can be used to correct the acidity of the soil. Lime increases phosphorus, nitrogen, potassium and molybdenum content in the soil.

Saline and alkaline soils

Saline soil

In such a soil, a white layer of salts is commonly seen on the surface. This is due to the presence of excess chlorides and sulphates of sodium, calcium and magnesium. It contains enough soluble salts to interfere with the growth of most crop plants. The presence of exchangeable sodium is less than 15 per cent and the pH is below 8.5. Electrical Conductivity (EC_e) is 4 dSm^{-1} or more at 25 ºC.

Saline-alkaline soil

Such soil contains adequate quantity of soluble salts. Besides, exchangeable sodium is more than 15 per cent in the soil. The pH of saline-alkaline soil is 8.5 or more. The EC_e value is more than 4 dSm^{-1} at 25 ºC.

Alkaline soil

Alkaline soil is poor in aeration and drainage. The pH of such soil is 8.5–10. The presence of exchangeable sodium is more than 15 per cent. EC_e value is less than 4 dSm^{-1} at 25 ºC. The high sodium content present in the soil is often toxic for crop growth.

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Causes of soil salinity

- Arid and dry conditions
- High water table
- Sloppy land that washes out salts in catchment areas
- Irrigation with saline water
- Poor drainage

Reclamation methods

- The application of gypsum (Calcium sulphate) is effective for the improvement of alkaline or sodic soil. It reacts with the exchangeable sodium present in the soil and converts it into Sodium sulphate. Sodium sulphate is leached out from the soil to reduce the soil pH.
- Saline soil can be improved by ensuring effective drainage system.
- Scrapping off surface salts from highly saline patches is beneficial for the soil.
- Use of acidifying fertilisers, e.g., superphosphate and Ammonium sulphate is also beneficial.
- Green manuring with *dhaincha*, sunhemp, *mung* bean, or addition of organic matter reduces the salinity of the soil.

Soil testing

Soil testing helps ascertain the status of various nutrients, soil fertility level, pH, etc. It is important to know the fertility status and physical properties of a soil for maximum production and rational soil management. A complete soil test programme essentially consists of three basic steps.

(i) Soil sampling
(ii) Soil testing
(iii) Soil test interpretation

Purposes of soil testing

- It helps evaluate and improve soil productivity.
- It helps determine the nature of the soil, i.e., alkaline, saline or acidic.

- It helps ascertain the use of fertilisers and manures, and their dosage in order to improve the fertility of the soil.
- It reveals the actual condition of the soil so that it can be improved with the application of nutrients and other management practices.

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Soil sampling

Soil tests and their interpretations are based on the collection of soil samples and their analysis. Therefore, soil samples that are taken represent the whole field. To obtain information about the nutrient status of a soil, it is essential to follow the correct procedure of soil sampling.

Before sampling information regarding the cropping pattern, various management practices, variations along with the direction of slope, soil colour and texture must be noted down. Then, the field from where the sample is to be collected must be divided into different sections, according to variations in slope and texture, and separate samples must be collected from each section. By using various sampling tools, such as soil auger, soil tube, spade, etc., the sample must be collected from plough depth, i.e., 15 cm for normal agronomic crops and from deeper zones, i.e., 15–30 cm for deep-rooted and horticultural crops at different spots, and then, all must be mixed thoroughly. This composite soil sample is then spread on a clean sheet. It is divided into four equal parts. Two opposite quarters are rejected and samples from the other two are mixed. To obtain the desired size of the sample (500 g), the same procedure is repeated. Before sending the sample to a laboratory, it must be dried and put into plastic bags. The bags, containing the samples, must be labelled and sent to the nearest soil testing laboratory, along with an information sheet having the following details.

- Name and address of the farmer
- Identification mark or number of the field
- Date of sampling
- Local name of the soil, if any
- Colour of the soil (dry and moist)
- Type of land (unirrigated, irrigated or waterlogged)

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- Source of irrigation (canal, well or tank)
- Depth of sampling
- Topography (level, sloppy or undulated)
- Crop rotation followed
- Previous crop
- Next crop to be taken
- Manures or soil amendments applied earlier
- Any other remark

The help of a village-level or extension worker can be taken to collect the soil samples and fill in the information sheet.

Sample analysis

The collected sample is analysed by using standardised method in a laboratory for the following parameters.

- pH (indicates whether the soil is acidic, alkaline or neutral in nature)
- Presence of total soluble salts (determined by EC, which indicates whether the soil poses any constraint to seed germination and subsequent crop growth)
- Lime and gypsum, if needed
- Organic carbon, which is a measure of nitrogen content in the soil
- Phosphorus content in the soil
- Potassium content in the soil

Soil test interpretations

Based on the soil analysis, data can be interpreted with the help of ratings as given in the following tables.

Table 5.1: Rating of soil on the basis of pH (1:2 soil–water ratio)

S. No.	Type of soil	Soil reaction (pH)
1.	Acidic	<6
2.	Normal to saline	6–8.5
3.	Tending to become alkaline	8.6–9
4.	Alkaline	>9

Table 5.2: Rating of soil on the basis of EC (1:2)

S. No.	Category	EC_e (dSm^{-1})
1.	Normal	<1
2.	Critical for germination	1–2
3.	Critical salt levels for growth of sensitive crops	2–4
4.	Injurious to most crops	>4

On the basis of the soil test interpretations, fertiliser recommendations for each crop may be made.

Table 5.3: Rating of soil on the basis of nutrient availability (1:2)

S. No.	Nutrients	Low	Medium	High
1.	Organic carbon	<0.5%	.5–.75%	>0.75%
2.	Available nitrogen (N)	<280 kg/ha	280–560 kg/ha	>560 kg/ha
3.	Available phosphorus (P)	<10 kg/ha	10–25 kg/ha	>25 kg/ha
4.	Available potassium (K)	<110 kg/ha	110–280 kg/ha	>280 kg/ha

Practical Exercise

Activity

Demonstrate the procedure of soil sampling.

Material required: Soil auger, test tube, spade, cultivated field, paper bag, polythene bag and tag.

Procedure

- Divide the field into different homogenous units based on colour, slope and texture of the soil.
- Remove all surface leaf litter, weeds, etc., at the sampling spot.
- Dig a 'V'-shaped cut at a depth of up to 15 cm, and then, draw a uniform slice of 15 cm. Collect the soil sample up to a depth of 15 cm without digging the soil with the help of soil auger.
- From each sampling unit, collect at least 10 samples.
- Remove foreign material present in the soil, such as stones, pebbles, fine roots, etc., and mix the samples.
- Divide the collected samples into four equal parts.

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- The two opposite quarters are removed and the remaining samples from the two other parts are again mixed. The process is repeated until the desired sample size is obtained.
- Dry the moist sample in shade.
- Collect the prepared sample in a sampling cloth or a polythene bag.
- Label the bag with the following information, i.e., name and address of the farmer, date of collection, previous and present crop record, crop to be grown in the next season, etc.

Check Your Progress

A. Fill in the Blanks

1. Alkaline soils are poor in __________ and drainage.
2. For deep-rooted horticultural crops, soil samples must be collected from _________ cm deep zone.
3. Green manuring or addition of organic matter reduces soil __________.
4. Desired size of the sample for soil testing is _____________.
5. The pH of saline-alkaline soil is __________.

B. Multiple Choice Questions

1. Soil acidity can be corrected by adding __________.
   (a) zinc (b) phosphorus
   (c) potash (d) lime
2. The major cause of soil salinity is _____________.
   (a) arid and dry condition (b) temperate condition
   (c) waterlogging (d) wet and humid condition
3. Available potassium is low in soil if it is _________.
   (a) <50 kg/ha (b) <100 kg/ha
   (c) <110 kg/ha (d) <150 kg/ha
4. White incrustation of salt is commonly seen in _________________ soil.
   (a) acidic (b) alkaline
   (c) saline (d) red
5. Soil is injurious to most crops, if EC (milli mohs/cm) is _________________.
   (a) >2.0 (b) >3.0
   (c) >4.0 (d) >5.0

C. Subjective Questions

1. Describe the problems of soil sampling.
2. Describe saline and alkaline soils.
3. Explain the reclamation method of saline and alkaline soils.

D. Match the Columns

A	B
1. Gypsum	(a) *Dhaincha*
2. Soil auger	(b) Poor drainage
3. Green manuring	(c) Corrected by lime
4. Soil salinity	(d) Soil sampling
5. Soil acidity	(e) Calcium sulphate

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Session 3: Field Preparation and Special Practices

Before starting to grow flower plants in a garden, there are some important activities that must be performed for the sustainability of land and other resources. These activities involve primary land preparation and various cultural operations, which must be done prior to the sowing or transplanting of flower plants. The main purpose of field preparation is to provide the necessary soil conditions and escape to the plant from biotic and abiotic stress. This will be helpful in the successful establishment of ornamental plants in a garden.

Selection of site

Climate, soil and location are the prime natural components in choosing a site on which the success or failure of flower crops depend. Careful site selection results in the success of flower cultivation. Different climatic components, such as temperature, rain, atmospheric humidity, altitude, hailstorm, and wind velocity and its direction must also be studied. However, high and low temperatures, as well as, hails are encountered mostly in subtropical plains. Low temperatures and winds mostly occur in hilly areas.

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Various factors like soil texture, structure, chemical composition, moisture and temperature of the soil must be taken into account while selecting a site. The location of the site determines its connectivity, exposure to the Sun, nearness to the road, availability of irrigation water, topography, etc.

For a flower grower, basic information regarding soil and climatic conditions, and its influence on growth and flowering of a crop is necessary. Different flower crops differ widely in their soil and climatic requirements. Distance of the garden from market will determine the flowers that can be grown and which marketing facilities are available nearby. Soil for open flower cultivation needs to be fertile and rich in organic matter content, near a water source and well-drained. The soil pH range must be neutral or near neutral. The availability of certain nutrients is strongly influenced by pH as micronutrients, such as manganese, iron, copper and zinc, become less available in highly alkaline soils. Land with a gentle slope is more suitable for successful and profitable flower cultivation. Easy availability of labourers and transportation of crops for economic gains is also essential.

Optimum conditions for growing flower crops

Ornamental flower crops such as celosia, *amaranth*, *kochia*, gaillardia, gomphrena, zinnia, torch lily, cosmos, etc., grow at or above 40 ^{0}C. But most commercial ornamental crops, such as rose, carnation, gerbera, gypsophila, statice, marigold, chrysanthemum, heliconia, bird of paradise, amaryllis, hippeastrum, etc., grow comfortably at 15–30 ^{0}C, Usually, for flower crop cultivation, sandy loam soil, containing adequate humus with a pH range of 5.5–7.5 is preferred as most of the crops remain comfortable in such soils. Such soil is easily workable, more beneficial for soil microbial activities, has adequate porosity, water retention capacity and provision for easy access to drainage.

Tools and equipment used in field preparation

Harrow, cultivator, plank, spade, *khurpi*, etc., are required for field preparation. The equipment may be used either manually or with the help of a tractor or may be animal-driven.

Preparation of field

For the cultivation of flowers, the field must be first made free of weeds, roots and stubs of previous season crops. Before the second ploughing of the field, light irrigation must be carried out in order to provide optimum moisture for the germination of weed seeds. The third ploughing may be done at the optimum stage of moisture by hand with a traditional hoe in a small area or by a tractor or animal-drawn cultivator, plough, etc. The depth of ploughing must be kept at 20–25 cm as superficial ploughing will not favour plant development, whereas, ploughing too deep will bury nutrients beyond the reach of the roots of the crop plant. Care must be taken that ploughing is done few weeks before the sowing of seeds to allow enough time for the weeds and crop residues to decompose. After every ploughing, planking is carried out, and then, finally, the levelling of the field is done. Levelling is, usually, done in two phases.

- The first levelling is done to lower the higher parts of the field, from where the soil is spread out over the lower areas.
- The second and more precise levelling is carried out after ploughing for sowing.

The main objective of land preparation is to create a favourable environment for growing flowering ornamentals. Land preparation will help in:

- irrigating the field and keeping it well-drained.
- improving the soil structure (better aeration, permeability and loosening of the root zone) to make easy germination of seeds and penetration of roots.
- maximum and best utilisation of nutrients supplied through fertilisers.
- minimising the growth of weeds.

Harrowing

It is an operation, which is carried out for breaking up and smoothening the hard surface in order to provide

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tilth of the soil structure, which is suitable for the sowing of seeds. A harrow can be used to remove weeds from the field and cover the seeds after sowing.

Purpose of harrowing

- To make the soil of the seedbed friable in nature
- To remove grasses and weed seeds from the field by pulling
- To cut and mix weeds and crop residues into the soil
- To make the field surface levelled by breaking the clods
- To break the capillaries to retain the moisture present in the soil

Special practices in flower cultivation

Weeding

It refers to the removal of all unwanted plants from the field other than those planted or sown. Periodic removal of weeds is beneficial for the growth and development of a crop as it prevents the competition of weed with the main crop for sunlight, water, air and nutrients.

Weeding is necessary as weeds harbour many insect-pests and diseases. Primary weeding is done to clear huge amounts of plants other than the main crop. In our country, weeding is, generally, carried out manually. Mechanical weeding may conveniently be carried out in crops that have been sown or planted as per specification and in rows. Chemical weeding can be carried out anywhere in any crop. However, it may have side-effects on the environment. Therefore, mechanical weeding is always preferred. Mulching at the initial stage also minimises weed population.

Mulching

Mulching is a protective layer of material spread on the top of the soil. It consists of organic wastes like straw, hay, dry grass or leaves, sawdust, crop residues, etc., or synthetic material like plastic sheets. Mulching is a cultural method that preserves soil moisture, checks soil erosion and protects from weeds. It also helps in maintaining the soil temperature.

Staking

Staking is a practice to support plants to grow straight and save them from bending or lodging. Therefore, this operation is done at a time when the plants are not too tall. It saves the plants from getting blown over due to wind, rain and weight of its flowers or fruits when in bloom or fruiting. Bamboo stakes are the most common thing used for the purpose. However, branches of shrubs and trees, such as neem, *subabool*, *phalsa*, eucalyptus, etc., can also be used for staking.

Advantages

- More plants can be grown as staking helps save space.
- It keeps the stem of a plant off the ground.
- It is easier to harvest as staking facilitates working among plants.

Earthing-up

Digging and pulling the soil in between rows and heaping it around the stem of plants is called 'earthing-up'. In case of bulbous ornamentals, this encourages the development of additional underground food storage structures, such as bulbs, corms, rhizomes or tubers as in case of tuberose, gladiolus, canna, begonia and dahlia.

De-shooting

De-shooting is the removal of all side shoots (offshoots, offsets or keikis), emerging from the base of a plant. The main purpose of de-shooting is to divert the energy of the plant towards the development of shoots and buds.

Disbudding

Disbudding is the removal of floral buds when a large flower is desired on a plant like in chrysanthemum and dahlia. Hence, the energy saved by disbudding is

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diverted towards the development of the retained bud so that the flowers become large and vigorous. Generally, it is followed in large-flowered varieties. The ideal time for disbudding is when the buds surrounding the central one have developed 5-cm long pedicels. Disbudding starts in October or as soon as the flower buds appear. In carnations, disbudding is practised to obtain long stalks with larger blooms.

Pinching

It refers to the removal of growing tips of the terminal portion of plants in order to promote bushy growth for more number of flowers as in case of chrysanthemum. It is the removal of 3–5 cm growing tips when the plants are 8 to 10-cm tall, i.e., when they are about one-month old. The second pinching is done about three weeks after the first pinching.

Training

It is the shaping of plants, conforming to a particular form commensurate to the plant's requirement at an early stage. This gives the plant a desired height, shape and strong framework with desired number of branches and eliminates weak crotch development.

Pruning

Pruning is the process to remove unproductive and diseased or dead branches and roots to improve plant health or quality of flowers, fruits and foliage.

Objectives of pruning

- To reduce the apical dominance of the plant so that the lateral branches are encouraged for quality blooms
- To build a balance between shoot and root growth
- To give a definite direction and shape to the plant
- To utilise the available space effectively
- To impart dwarfing in the plant and promote its healthy growth
- To improve the productivity and quality of the produce

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- To impart definite objective, such as development of dense top growth in a shady tree, or to keep a neat and impenetrable hedge
- To provide necessary light and air to the inner portion of the plant
- To remove all dead, diseased and interlacing twigs and branches

Time of pruning

- The plant bearing flowers on the last season's growth is, generally, pruned immediately after flowering.
- The plant, which produces flowers on the current season's growth, must be pruned sufficiently in advance ahead of the flowering season.

Methods of pruning

The methods of pruning vary with the plant specimen as ornamental trees hardly need any pruning. Hence, only shrubs are subjected to pruning in the following ways.

Clipping or shearing of hedge

Regular pruning is carried out in hedge plants in order to maintain their shape-cum-beauty, symmetry and health and encourage branching from the base so that they become impenetrable to cats and dogs. Square-cut, round-top, wavy-top, columns, etc., are given through training and pruning. During early age, shrubs are headed back frequently to induce branching from the ground level till the required height is attained. Thereafter, these are sheared frequently during the rainy season.

Topiary

The art of clipping and shearing climbers, shrubs, small trees and herbaceous perennials into artistic shapes is known as 'topiary'. Plants with small dark green foliage amenable to frequent clippings and shearing are selected for topiary making. It takes years to train a plant to reach a desired shape and size. Simple shapes like globe, sphere, dome, table and cube to difficult objects like birds, animals or humans can be made only with patience. The shapes of difficult objects are obtained by training plants with the help of wire frames.

The Hanging Gardens at the Kamala Nehru Park in Mumbai is famous for its topiary work. Shrubs, such as *Clerodendrum inerme (*Indian privet*)*, *Duranta plumieri* (*duranta*), bougainvillea, *Murraya paniculata* (*kamini*), *Thuja* (*morpankhi*), *Cupressus sempervirens* (Italian cypress), *Putranjiva roxburghii* (*putranjiva*), *Vernonia elaeagnifolia (*curtain creeper, vernonia creeper, parda vel) and *Polyalthia longifolia* (*ashoka*) are, usually, used for making topiary.

Practical Exercise

Activity

Demonstrate weeding, earthing-up and staking in a gladiolus field.

Material required: Gladiolus crop, *khurpi*, spade, bamboo stakes and jute twine (*sutli*)

Procedure

- Remove all weed plants from gladiolus crop.
- Earth-up the plants with surrounding soil (10—15 cm above the ground level) from all sides with the help of a spade.
- Dig straight bamboo stakes about 5 cm away from the plants so that the developing corm and cormlets are not injured.
- Loosely hold the plants with the spikes straight with stakes and tie them with the help of a *sutli.*
- Care must be taken that the *sutli* is not tied tightly.

Check Your Progress

A. Fill in the Blanks

1. Breaking-up and smoothening out the surface of the soil is done by _______________.
2. Weeding refers to the removal of _______________ plants growing in a field.
3. Mulching is a ___________ layer of a material that is spread on the top of the soil.

4. The removal of side shoots of a plant is known as ________________.
5. Disbudding is the removal of __________________.
6. The art of shaping a plant at an early stage is called _____________.

B. Multiple Choice Questions

1. Inorganic mulch is ______________.
   (a) straw (b) dry grass
   (c) sawdust (d) plastic sheet
2. Earthling-up is a common practice in ______________.
   (a) rose (b) marigold
   (c) gladiolus (d) carnation
3. Pinching in a plant promotes _______________.
   (a) plant height (b) flower size
   (c) bushy growth (d) root growth
4. Giving definite direction and shape to a plant is known as ____________.
   (a) pruning (b) pinching
   (c) disbudding (d) de-shooting

C. Subjective questions

1. Describe the procedure of field preparation.
2. Write in brief on the following:
   (a) Weeding (b) Mulching (c) Staking
   (d) Earthing-up (e) De-shooting (f) Disbudding
   (g) Pinching (h) Training (i) Pruning

D. Match the Columns

A	B
1. Topiary	(a) Removal of flower bud
2. Training	(b) *Thuja*
3. Disbudding	(c) Removal of the growing tips
4. Pinching	(d) Shaping of the plant

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