

Ecological Factors

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Intro. :-

The things of the world are classified into two major groups namely living or biotic component and the non-living or abiotic component. The biotic components includes all types of living organisms both plants and animals and the abiotic component includes the non-living materials (soil, water, air, etc).

Every aspect of life gets influenced by the environment. An aspect of biology which deals with the inter-relationship betⁿ biotic and abiotic components as well as the relationship betⁿ among the individuals of the biotic component is called ecology.

Ecology is that branch of biology which deals with the study of plants and animals in relation to their environment.

The word 'Ecology' have been firstly proposed by the German biologist Ernst Haeckel in 1869.

The word ecology is derived from the Greek 'oikos', meaning "house" or place to live. Literally, ecology is the study of organisms or groups of organisms to their environment.

Victor Shelford defined ecology as the "science of the community".

Eugene Odum (1963) defines ecology as "the study of the structure and function of the nature."

(2) Date

* plant and Environment

If we study the geographical distribution of plants or a group of plants we find that different kinds of plants grow in different sets of environmental conditions.

The distribution of plants, their physiognomy (ब्युत्पत्ति) and phenology (अनुसंधान) (changes in seasons / causes change in plants), behavioural adaptations are all regulated by the conditions of the environment in which the plants grow.

The various conditions which affect the form and functions of the plants either directly or indirectly are termed environmental factors or ecological factors.

The life of a plant is related with the environmental factors of a place that every species of plant seems to be fitted to a particular set of environmental condition within which it grow.

The ecological factors can be classified under 4 major groups

(1) climatic (2) Edaphic

(3) Topographic (4) Biotic

Though the environmental factors have to be studied individually, it should be noted that they do not act in isolation from one another. All factors interact with one another to influence the organism.

Scope of Ecology

Ecology, like biology, has been subdivided into plant ecology and animal ecology.

- Ecology may be divided into Autoecology and synecology.

- Autoecology:- It is a study of interrelationship between individual species or its population and its environment.

- synecology:- It deals with the systems of many species. Whole community or major fraction of community and ecosystems is termed synecology.

- Different fields of ecology are as follows,

① Habitat ecology:- It deals with the habitat of plants and animals.

② paleoecology:- It deals with the organisms and geological environment of the past.

③ cytoecology:- deals with the cytological details of the species or populations in relation to different environmental conditions.

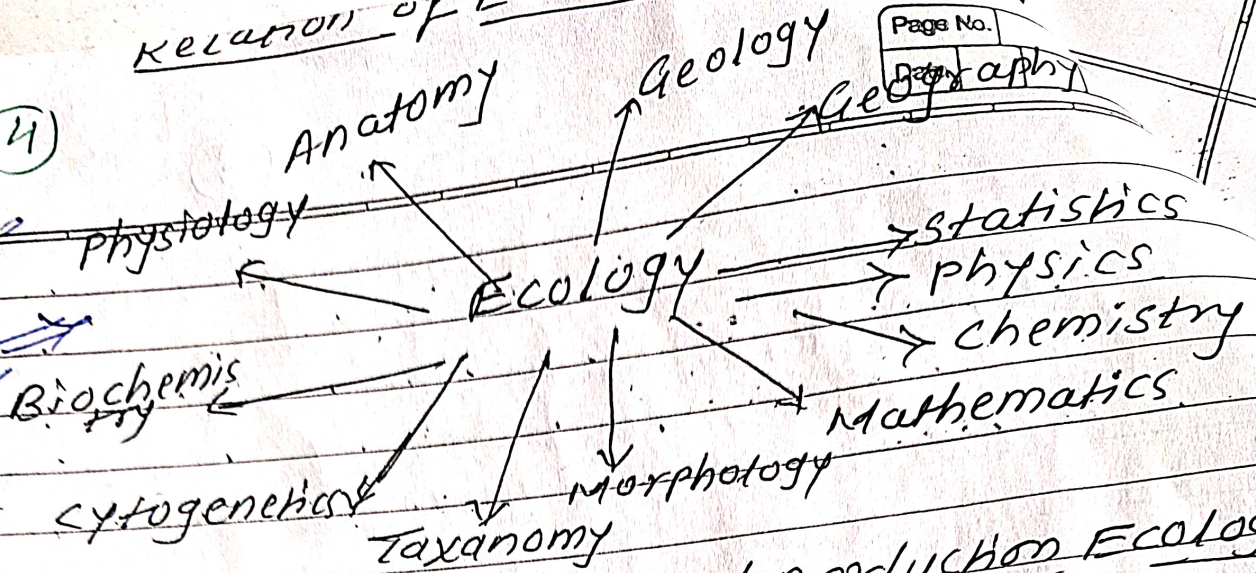
④ Ecosystem ecology:- study of ecosystem.

⑤ conservation or resource ecology:- It deals with the proper management of plants, animals, soil, water and mineral resources for human welfare.

Relation of Ecology with other

Relation of Ecology with other sciences

(4)



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(6) Ecological energetics and production Ecology.
These deals with mechanism and quantity of energy conversion and flow of energy through organisms.

(7) Ecology and branches of science :-
Ecology has relation with morphology, taxonomy, physiology, biochemistry, cytology, genetics, etc. and other science such as physics, mathematics, statistics, geology, geography, etc. as shown in above figure.

Applications of Ecology

- (1) To conserve natural resources
- (2) controlling soil erosion, reforestation, restoration of wild animals, Flood control, etc.
- (3) Need of silviculture
- (4) It has given the knowledge of pollution and its control.
- (5) conservation of endangered species.

11] Climatic factors

(related to aerial environ)

The atmospheric factors which affect the plants are called climatic factors. They are as follows,

- (a) Water
- (b) Atmospheric moisture
- (c) Temperature
- (d) Light
- (e) Wind velocity
- (f) Atmospheric gases

(a) Water

The role of water in growth and development of a plant is of great importance.

Water is an essential component of protoplasm of living cells.

The hydration of the protoplasm is essential for its correct organization and for the proper functioning of the organelles they contains.

Water is the medium for the movement of gases, minerals, etc. within the plants.

Water takes part in the many metabolic reactions taking place in the cell e.g. photosynthesis.

Different organic constituents of plants such as carbohydrates, proteins, nucleic acids and enzymes lose their physical and chemical properties in absence of water.

Water helps in ~~transmission~~ in the mobility of gametes, in the ~~stessimination~~ of spores, fruits and seeds, ~~provides support~~. It increases the rate of respiration. seeds respire fast in presence of water. Water is a source of hydrogen atoms for the reduction of CO_2 in the reactions of photosynthesis. Water present in the vacuoles helps in maintaining turgidity of cell which is a must for proper activities of life.

Precipitation (पड़सन्धमान / Rain)

Water is the most important factor controlling the type and distribution of plant communities.

Rainfall in fact increases the moisture content of the soil and the humidity of the atmosphere.

precipitation takes place when warm air full of water vapour from oceans, rivers, lakes, streams, ponds moves up to colder belts of the atmosphere. The water vapours cool off at these heights and condense in the form of water drops.

The number of rainy days plays a very imp. role in determining the vegetation of a place.

The regions with the same amount of rainfall but considerable difference in the number of rainy days will have entirely different types of vegetation.

^{Heavy} Rain on fewer days usually results in great surface runoff and the plants get much less water.

- If the rainfall is moderate and occurs uniformly on larger number of days, the plants are highly benefitted.

- small quantities of rain are of little or no use to the vegetation, because evaporation is rapid and the water evaporates before it can sink into the soil.

- The vegetation of particular area is determined by the amount of rainfall.

- As a result of rainfall, three distinct kinds of vegetations are formed namely forests, grasslands and deserts.

In the warm tropics heavy rainfall distributed throughout the whole year results in evergreen rain forests. Heavy rainfall but confined to a few months in a year results in deciduous forests.

Grasslands are found in the regions of high summer rainfall and low winter rainfall. Deserts are found in the regions of very low summer and winter rainfall.

- Extremely low rainfall or complete absence of rainfall accompanied with very high temp. results in droughts.

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कटिबंध

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(b) Atmospheric moisture

Humidity:- Water is always present in the atmosphere in the form of invisible water vapour. This is known as humidity of the air.

- When the atmosphere contains the maximum amount of water vapour, it is said to be saturated with water. An increase in temp. will make the air unsaturated.
- The relative humidity of a place is also affected by wind, exposure, vegetation and water content of the soil.

Effect of atmospheric moisture on plants

- (1) Atmospheric humidity is directly absorbed by epiphytes, mosses, lichens and other plants. Dewdrops are also absorbed by the leaf surfaces of the plants.
- (2) Atmospheric humidity reduces the intensity of light falling on the earth's surface. Thus plants receive excessive sunlight in dry conditions, and exhibit several xeromorphic features.
- (3) Atmospheric moisture in the form of fog and mist are absorbed by the soil particles and are thus sources of soil moisture.
- (4) The evaporation of water from plants or a body of water is directly dependent

on the relative humidity of the atmosphere. The relative humidity or its direct control on the rate of loss of water by the plants, plays an important role in the type of vegetation of a place.

for ex: many cryptogamic plants ~~stems~~ grows in habitats where relative humidity is normally very high. They are called hygrophytes. Certain fungi and lichens show luxuriant growth in the presence of high humidity.

* cloud and Fog

When ^{air} moisture laden air cools down to a temp below its dewpoint () cloud and fog are formed.

- When air moves up from land surfaces to colder level of atmosphere, clouds are formed. on the other hand when cooling of the air takes place near the land surface fog is formed.

* snow :-

snow and sheets of ice are damaging to plants of all kinds. suffocation, lack of oxygen supply, accumulation of toxic substances are some of the minor effects of snow.

- A major injurious effect on plants is the breaking off the tree branches after a heavy snowfall.

- The plants growing in snow-capped regions have stunted growth and crooked stems. melting of snow results in good supply of water to streams and rivers.

The temp. of a place is largely determined by its distance from the equator, i.e. on the latitude of a place. The temp. is maximum at the equator and decreases gradually as one goes to the north or to the south.

The vegetation of the earth can, therefore, be grouped under different temperature zones, e.g. equatorial forest, tropical forest, coniferous forest, alpine vegetation etc.

Besides latitude and altitude, the temp. of a place is also affected by clouds, winds, water content of the soil, soil cover, slope, etc. Plant communities growing in different places are adapted for different temperature. There is wide range of tolerance of temp. among the plant species.

The sub-arctic conifer forests thrive at as low as -80°F whereas the desert plants can withstand temp. of 140°F .

Every plant community has its own minimum, optimum and maximum temperatures for its overall growth and development.

Effect of temp. on plants

Temp. affects the rate of metabolic activities of plants.

The rate of photosynthesis and respiration

Latitude -
उत्तर/दक्षिण
Altitude -
उचाई

increase with increase in temp.

- High temp decreases the relative humidity of the atmosphere and this increases the rate of transpiration. Conversely, decrease in temp, increases relative humidity and this reduces the rate of transpiration.

- High temp accompanied with heavy rainfall results in very luxuriant vegetation of great diversity, e.g. the tropical rain forests.

In the temperate region the plants are adapted for low temp. and the vegetation consists of coniferous trees like pine and dicots like oaks, birches and chestnuts.

- In very cold polar regions of tropical or temperate mountains, the plants ~~grow~~ remain dwarf.

(d) Light

Light as a factor is not as important to a plant ecologist as it is to a plant physiologist. It is one of the most important climatic factor for many vital processes of the plant.

Light is necessary for the synthesis of food. The chlorophyll of plants absorbs light energy (radiant energy) and convert it into chemical energy of carbohydrates.

Light also affects on the ~~rate~~ regulation of rate of transpiration by controlling the opening and closing of stomata.

Light intensity :-

Light intensity falling at a particular place is normally enough for the plants and their physiological processes, viz. photosynthesis, etc. In photosynthesis only 1% of the light energy is converted into potential chemical energy.

However very low light intensities reduce the rate of photosynthesis and sometimes may even result in the closing of the stomata (CO₂ entry is checked). This results in reduced vegetative growth of plants.

very high intensities ~~of~~ affect the plants in so many ways. It increases the rate of respiration and thus disturbs the

photosynthesis - respiration balance.
It also causes rapid loss of water which often results in closing of stomata.

The most harmful effect of high light intensity is the phenomenon of solarization in which all the cell contents are oxidized by atmospheric oxygen. This oxidation is different from respiration and is termed photo-oxidation.

Quality of light

The different wavelengths of the visible light do not have any effect on the plants. only ultraviolet light kills the bacteria and many fungi. It induces anthocyanin formation and also affect phototropism.

Light duration :-

The duration of total light period in a year and the duration of daily light period (photoperiod) at a particular place have pronounced effect on the vegetative as well as reproductive (flower) structures of plants.

Plants growing near the equator have luxuriant growth which is uniform because the length of day is almost uniform throughout the year. But in northernmost and southernmost latitudes plants grow smaller because the number of days when light is available is far less.

similarly, areas having many sunny days produce better vegetation than areas having many cloudy days.

The daily light period has a ~~marked~~ marked effect on the flowering of a plant. The plants have been classified into three groups according to their photoperiods,

- ① Short day plants.
- ② Long day plants.
- ③ Day neutral plants.

Most of the plants belong to first category i.e. short day plants. They require a relatively long period of uninterrupted darkness for flowering.

Long day plants require a photoperiod of more than a critical length which varies from 4 to over 18 hours. They require either relatively small period of darkness or no darkness at all.

Day neutral plants can flower in all possible photoperiods ranging from few hours to 24 hours of uninterrupted light exposure. They are called photoneutral plants.

② wind velocity

Effect of wind on vegetation

The velocity of wind has very imp. effect on the vegetation of a place. Following are some of the effects on the vegetation of plant,

① Breakage :-

A very high wind velocity (such as hurricane) breaks dead and living branches of trees and even uproots them completely. The effect of wind velocity is less on a dense forests.

② soil erosion :-

In bare deserts high velocity of wind causes constant soil erosion, which makes it difficult for a plant to grow there. To check soil erosion in deserts and protecting plants, a dense strip of tall vegetation (betⁿ 50-200 feet) is planted to act as windbreak. Wind is also responsible for causing rainfall to a very large extent.

③ Deformation :-

constant strong winds blowing from one particular direction cause bending of the trees and their branches to one side. This can be clearly seen in coastal ~~and~~ or mountain side plants.

- (4) Lodging :- plants like wheat, maize, sugar-cane fall flat on the ground due to injury caused by strong winds. The phenomenon is called as lodging.

An imp. function of winds is to help in pollination of flowers and dispersal of seeds, fruits and microorganisms, etc.

- (5) Desiccation :- Dwarfing :-

On mountain slopes on the windward side the vegetation is exposed to strong unidirectional winds. The drying effect of wind results in small dwarf trees, shrubs and prostrate plants. On the leeward side the plants are protected from strong winds and, therefore the vegetation consists of tall trees.

(F) Atmospheric Gases

The atmosphere surrounding the earth contains three important gases viz. CO_2 (0.03%), O_2 (~~21%~~^{21%}) and N_2 (79%).

(1) CO_2 :-

The CO_2 is the main source of carbon for the various types of organic components in the body of plants. It is one of the minor constituent of the atmosphere.

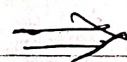
CO_2 is the main raw material for the manufacture of carbohydrates ~~is~~ by the photosynthetic process of the green plants.

The CO_2 which gets incorporated into the organic compounds of plants returns to the atmosphere by respiratory breakdown of these compounds.

(2) O_2 :-

Every living being, whether plant or animal, sustains its life because of oxygen. Atmospheric O_2 is vital to its life and normal growth.

The amount of O_2 ~~is~~ is normally constant in the air because plants give off oxygen during photosynthesis which replaces the oxygen consumed in respiration.



(3) N_2 :- The nitrogen of the atmosphere cannot be directly fixed by living beings. Only the leguminous plants are capable of doing so with the help of certain bacteria.

The atmospheric nitrogen made available to the soil by lightening, rainfall and nitrogen fixing microorganisms.

The nitrogen content of the plant is largely consumed by animals as food. Part of this nitrogen is again returned to the soil in the form of animal excreta or dead animal tissues.

(Related to soil)

The branch of science concerned with the study of soils is called pedology.

Importance of soil to plants

The land plants are completely dependent on the soils in which they grow for anchorage, water and mineral nutrients.

Types of soil and vegetation

Several types of vegetation have been recognized to develop as a direct result of the nature of soil.

For ex: -

Rock soil — lithophytes
sandy soil — psammophytes
Humus soil — oxalophytes
cold soil — psychrophytes.

x Soil profile

soil may be defined as the superficial covering of the earth's surface.

The soil layer has been formed by the weathering of the rocks in the past.

As a result of soil formation factors, a soil has certain definite structural and positional characteristics which is known as soil profile.

A soil profile is distinguished into 3 distinct zones called horizon A, B and C starting from surface downward.

The horizon A is generally referred to as topsoil. It is the uppermost layer and contains undecomposed, partially decomposed and completely decomposed humus arranged in a downward manner. Topsoils differ widely in colour, according to the types of minerals and humus components.

Topsoil is largely sandy. The roots of small plants grow in the top soil only.

The roots of larger plants extend to the horizon B, which is also called the subsoil.

The subsoil contains minerals and is often high in clay content. The fine clay particles make the subsoil dense and, therefore it becomes impermeable to water movement.

It is poorly aerated and hence roots have little growth in this portion of the soil.

The horizon C contains loose weathered rock which may or may not be always prominent.

Below the soil profile is normally present the hard rock.

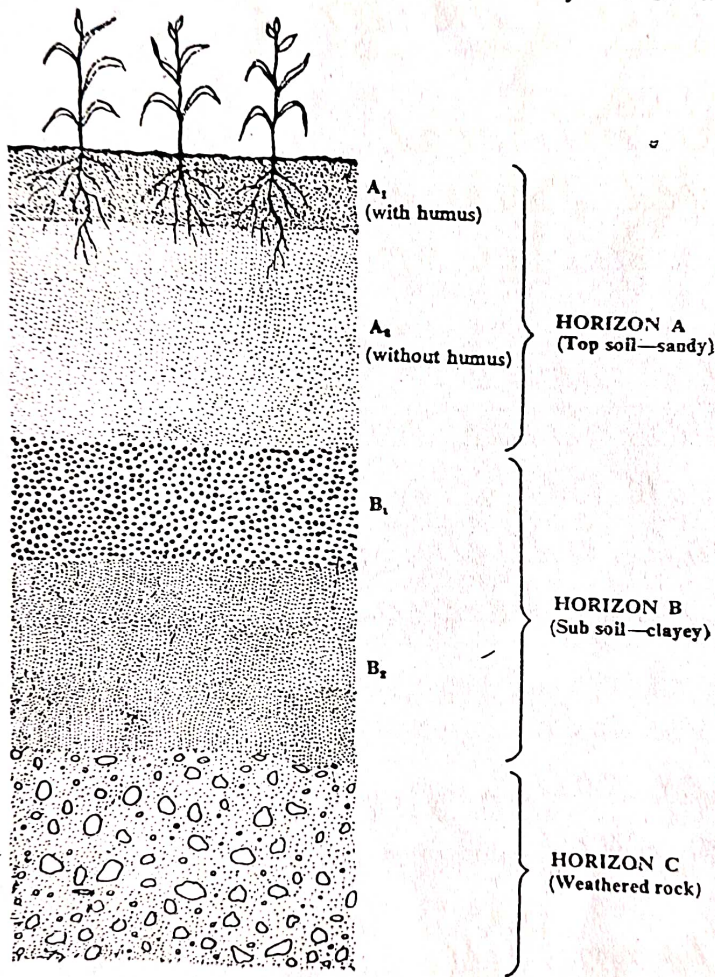


Fig. 18. . A section of soil profile.

Fig :- soil profile

composition of soil

There are 4 important components of the soil.

- mineral matter - - - about 40%
- organic matter - - - about 10%
- soil water - - - about 25%
- soil air - - - about 25%

(a) Mineral matter :-

The mineral content of the soil is derived from the weathering of rocks and consists of particles of different sizes.

Soil texture : The texture of the soils is determined by the relative proportion of rock particles of the different sizes present in them. on the basis of textures, soils may be classified into 6 types,

- sandy soils - - - chiefly sand
- clayey soils - - - chiefly clay
- Loam soils - - - sand, slit and clay in equal percentage
- sandy-loam soils - - - sand predominant
- slit-loam soil - - - slit "
- clayey-loam soil - - - clay "

* Sandy soils have the following characteristics,

- 1) Loose or light textured.
- 2) Loose space betⁿ particles.
- 3) ~~Hi~~ water holding capacity poor.
- 4) Fertility poor due to lack of nutrients.
- 5) Aeration good.
- 6) No water run off.
- 7) CO₂ content low.
- 8) Humus content low.
- 9) suited for deep-rooted perennials.

* Clayey soils have the following characteristics,

- 1) compact and heavy textured.
- 2) small interspaces betⁿ the particles.
- 3) Water holding capacity good.
- 4) Fertility good.
- 5) Aeration poor.
- 6) CO₂ content high, toxic to plants.
- 7) Humus content high.
- 8) Run off of water.
- 9) suited for shallow-rooted plants.

Loam soils are the best for the growth of plants since they contain sand as well as silt and clay particles.

Loam soils, therefore has good aeration, good water infiltration and water movement, good water holding capacity and good fertility (due to presence of clay).

(b) organic matter

The organic matter is added to the mineral matter of the soil year after year. It has a marked effect on the vegetation of a place. It comprises the soil humus as well as the soil organisms.

soil humus :- The organic matter of soil is derived from

- (i) dead and decaying roots of plants and living organisms present in the soil, and
- (ii) dry leaves, twigs, dead plants and animals.

Advantages of soil humus :-

The soil humus is advantageous for the growth of plants in following ways,

- (i) Great water holding capacity in both sandy as well as clayey soils because it has the properties of colloids.
- (ii) Source of mineral nutrients. It increases fertility of the soil.
- (iii) It binds clay particles ~~into~~ to facilitate infiltration of water.
- (iv) It makes the clayey soils porous and thus increases its aeration.
- (v) It is source of food for most of the soil organisms.

soil organisms : The microorganisms which are almost present in soil are the constituents of organic matter. They have very important influences on the plant life.

chief roles of soil organisms :-

i) Decay and the nutrient cycles :-

A large number of bacteria and fungi bring about the decay of the dead and rotting organic substances.

- The carbohydrates, proteins and fats of dead plants and animals are broken down into CO_2 , water, ammonia, methane and inorganic compounds of sulphur and phosphorus.

- The mineralization process releases a variety of nutrients to be made available to the plants.

- The ammonifying bacteria converts proteins into ammonia ~~and increases fertility of soil~~
The nitrifying bacteria oxidize ammonia to nitrites and nitrates and thus increases fertility of soil.

ii) Nitrogen fixation :-

The fertility of soil is also increased as a result of nitrogen fixation brought by several bacteria and blue green algae.

In legume roots *Rhizobium* fix atmospheric nitrogen, In aerated soils *Azotobacter*, un aerated soils *clostridium* fixes atmospheric nitrogen.

iii) production of toxins:-
 sometimes due to incomplete decay, the organic matter is deposited in the form of peat. If the soil is poorly aerated the organic compounds are reduced instead of being oxidized. This results in substances like aldehydes, organic acids, etc which are strongly toxic to many species of higher plants.

iv) pathogenic bacteria and mycorrhiza:-
 some of the bacteria as well as fungi are pathogenic and cause diseases of plants.

some of the fungi form mycorrhizal association with root system of higher plants for helping them in the absorption of water, minerals and even in organic nutrition.

v) Soil mixing and aeration:-
 The larger organisms like earthworms, rodents etc. improve the aeration of the soil to a very large extent. They burrow deep into the soil forming tunnel like passages through which oxygen of the air enters the soil and CO₂ gets out of it.

They also bring about mechanical mixing of the soil by bringing the subsoil to the surface.

The earthworms also consumes large amounts of soil from the deeper layers of soil and deposit them in the form of

casts on the surface of the soil.

The aeration and mixing of the soil increases the fertility of soil.

(c) Soil Water:

The water content of the soil is more imp. than any other ecological factor. Soil water is directly taken up by the plants for their life and growth. Besides, soil water also act as a medium for salts needed in plant nutrition.

Shortage of water in the soil results in poor growth of the vegetation. While excess of soil water on the other hand, is also harmful to the plants. Water-logging causes poor aeration of the soil which results in little absorption of water by the plants.

(d) Soil Air:

In well-aerated soils CO_2 released in respiration of roots and microorganisms is freely exchanged with the air above the soil.

Aeration of the soil is absolutely essential for the absorption of water by roots.

Absorption of water by the roots takes place at a rapid rate in well-aerated soils, and oxygen is needed for the respiration of roots. The energy released in the respiration is

essential for the growth of the roots and the emergence of fresh root hairs which are essential for the continued absorption of water.

soil air is also useful in increasing the fertility of the soil.

(c) Soil temperature

soil temp depends upon the following factors,

(i) colour and composition of surfaces :-
The amount of heat absorbed by a soil surface depends upon its colour and composition. white soil reflects all radiation and is therefore cooler as compared to black soils, which absorbs it completely.

If the surface of soil is covered with thick vegetation, then surface receives less radiation.

(ii) Plant cover :- An area covered with forest remains cooler during the day and warmer during the night as compared to the adjacent open areas.

During ^{the} day the shade prevents the heating of soil by radiation. The heat is also absorbed ~~th~~ by the cool soil of the shaded areas.

(iii)

Snow cover :- Reflection of light from a white snow surface increases the temp. of the adjoining areas during the day while reradiation at night decreases the temp.

- The temp. (increased) of the soil influence the rate of absorption of water and solutes, the germination of seeds and the rate of growth of the underground portions of the plant body.

- The maximum metabolic activities of the plants and the maximum absorption of water by the roots takes place generally betⁿ 20°C and 30°C.

⊕ Soil pH

Soil pH has a direct effect on the viability of plants and on the nutrient supply.

The protoplasm of root cells is badly damaged below pH 3 and beyond pH 9. Microorganisms are extremely sensitive to acidity while bacteria thrive in alkaline medium and are damaged below pH 6.

Most of the vascular plants can exist betⁿ pH 3.5 and 8.5.

Neutral or slightly acidic soils are best for the growth of majority of plants.

Soil acidity beyond a particular limit is injurious to plant growth. Some of the reasons of high acidity effects are listed below,

Neutral.
Acidic, pH above 7 - basic.
pH 7 -
pH below -

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- a) High acidity may be toxic to plants.
- b) High acidity interferes in the absorption of several nutrients.
- c) Decomposition of organic matter by microorganisms may be reduced.
- d) Solubility of certain essential nutrients like Ca, Mg, etc decreases reducing their availability.

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Unit

Question-Bank

Long answer questions.

15 mark

- ① What is meant by ecological factors? Describe it with climatic factors.
- ② Describe edaphic factors.
- ③ Describe the composition of soil.
- ④ Define soil. Give the detailed account of composition of soil.

⑤

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Short notes. 5 marks

① scope of ecology.

② Role of temperature on the growth of plants.

③ Effect of light on the vegetation.

④ Soil profile.

⑤ Soil temperature.

⑥ Soil pH.