Soil Microbiology

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Bacteria

*** Habitat:**

Bacteria are found on all habitats on earth, water, soil and air ,also are found inside the bodies of human and animals and plants, so bacteria causes the contamination of drinking water and food.

*** General characters of bacteria:**

(1) Bacteria a thallus plant

(2) Bacteria are atrichous or trichous such as monotrichous, lophotrichous, lamphitrichous, and peritrichous.

(3) Bacteria characters by many shapes such as coccus, diplococcus, tetra coccus,streotococcus,staphylococcus,bacillus,diplobacillus,diplobacillus,streptobacillus,spirllam,vibrio,spirochaete and Streptomyces.

(4) Bacteria not contains cell wall, but some time cell wall present.

(5) Classification of bacteria according to the presence or absence of the cell wall.

a-Mycoplasma ,gram positive, gram negative.

(6) Bacteria obtain their food requirements by different methods so bacteria are classified into 4 types according to their food requirement:

(a) Photoautotrophs: In which bacteria uses sun light as energy source and CO_2 as carbon source

(b) Photo heterotrophs: In which bacteria uses the light as energy source but obtain carbon from organic compounds.

(c) Chemo-autotrophs: In which bacteria oxidizes of inorganic compounds to obtain energy but uses of Co2 as a carbon source.

(d) Chemo-heterotrophs: In which bacteria oxidize or reduce of organic compounds to obtain energy and carbon.

-Most of bacteria characterized by the chemo-heterotrophs

-Some of bacteria (chemoheteotrophs) can live as saprophyte or parasite and causes diseases to plants, human and animals.

(7) Some bacteria play an important role in fertilization of the soil by nitrification and nitrogen fixation.

(8) Some of bacteria can live as facultative saprophytes or obligate saprophytes or parasites or facultative parasites or symbiosis.

(9) Reproduction in bacteria take place by:

(1) Binary fission. (2) Sexual reproduction (3) Sporulation. (4) Conidia.

***Economic importance of bacteria**:

(1) Many of bacteria causes diseases to human, plants and animals.

(2) Many of bacteria causes damage in food (food Poisoning).Milk considred the best medium for bacterial growth because it contains all the requirments for the growth of bacteria.

(3) Many of bacteria play an important role in industry such as fermentation ,retting,manufacture of alcohols and acids molasses,cheese and tobacco.

(4) Bacteria play a role in transfer of blood to human through formation of dextran from sugar cane which can uses as alternative to plasma of blood.

(5) Bacteria play an important role in fertilization of soil which causes increasing in crops.

***Classification of bacteria:**

Bacteria is classified into 19 groups depends on :

(1) The characteristic wall.

(2) Source of energy and carbon.

(3) Shape of cell.

(4) Method of movement.

(5) Requirement from oxygen.

(6) Sporulation or no sporulation.

(a) Phototrophic

(b) Gliding. (c) Sheat hed. (d) Budding or appendage

(e) Spirochaetes (f) Spiral.

(7) Gram-negative aerobic rods and cocci (8) Gram- negative facultative anaerobic rods.(9) Gram- negative anaerobic (10) Gram-negative cocci and cocco bacilli.

(11) Gram- negative anaerobic cocci

(12) Gram- negative chemoautotrophic.

(13) Methane producing bacteria.

(14) Gram positive cocci.

(15) Endospore forming rods and cocci

(16) Gram- Positive asporogenous rod-shaped bacteria.

(17) Actinomycetes and related organisms.

(18) Rickettsias.

(19) Mycoplasma.

***Environmental factors affecting on the growth of bacteria:**

(1) Temperature:

Most of bacteria grow and spread in medium temperature (mesophiles) at temperature (20-40 C). Most of these bacteria cause diseases to human and plant,but some of bacteria can grow in low temperature (psychrophiles) and some of bacteria can grow in high temperature (thermophiles) and cause some diseases to human.

(2) PH value:

The most of bacteria can grow and spread in PH(6-8) but there are a few types of bacteria can grow in acidity or alkaline medium.

(3) Food elements:

The growth and spread of bacteria increases in the presence of food elements and decreases in the absence of these elements.

(4) Oxygen:

The most of bacteria can grow and spread in the presence of oxygen and some of them can grow and spread in the absence of oxygen.

(5) Humidity :

Humidity effect on the growth and spread of bacteria where the high humidity cause incressing where the high humidity cause increasing in the members of bacteria but the low humidity cause decreasing in the growth and occurrence of bacteria.

(6) Osmotic pressure:

The most of bacteria can grow and spread in medium osmotic pressure effect on the growth and occurrence of bacteria.

(7) Light:

Some of bacteria increase their growth and spread in the presence of light where the light effect on the growth and spread of some types

of bacteria specially the ultra-violet rays effect on the growth of bacteria.

(8) Organic matter (humus):

Bacteria grow and spread in the presence of high humus but in the absence of humus the occurrence and growth of bacteria decreases

Actinomycetes

Actinomycetes are simple micro-organisms consists of hypha which from mycelium. Some of actinomycetes form spores from asexual reproduction and some of them form spores inside sporangium.

Actinomycetes similar to fungi in :

(1) Formation of branches

(2) Formation of mycelium and conidia

(3) When grow in liquid medium, the medium become clear

Actinomycetes are similar to bacteria in :

(1) Size and characters of hypha and conidia

(2) Some of genus not form aeral hyphae.

(3) In some morphology and physiology characters and relations with pigments.

(4) Some genus carry flagella and the structure of cell wall similar to the structure of cell wall in bacteria.

***Habitat:**

Actinomycetes spread in the soil and some of them are found in different environment where found in human ,animals and plants.

Most of saprophyte and some of parasites which causes diseases to human ,animals and plants.

***Environmental factors effect on the growth and spread of Actinomycetes.:**

(1) Type of soil :

Actinomycetes growth and spread increase in the soil which contain large amount of organic matter and their PH value 7 and decrease in acidity soil .Also they increase in the soil which contain herbs and cultivate soil.

(2) Amount of organic matter :

The growth and spread of actinomycetes increase in the presence of large amount of organic matter and decrease at low amount of organic matter.

(3) PH value:

The growth and spread of actinomycetes increase in PH=7 and decreases in acidity and alkaline medium

(4) Humidity:

Humidity effect on the growth and spread of actinomycetes where they increasing in humidity and water cause increasing in the growth and spread of actinomycetes until certain degree of humidity and water. The increasing of water than certain degree cause decreasing in the growth and spread of actinomycetes, these due to decreasing in the oxygen which effect on the growth and spread of actinomycetes.

(5)Temperature:

There is increasing in the growth and spread of actinomycetes in medium temperature (28-37 C) where large amount of organic matter present and these increasing in spring and autumn but the growth and spread of actinomycetes decreases in low and high temperature.

***The importance of actinomycetes**:

(1) Some of them secret enzymes and antibiotics which effect on bacteria and other micro-organisms

(2) Analysis of some compounds of plant tissues and animals tissues which resistant to analysis.

(3) Formation of humus through the conversion of remain plants and leaves into humus.

(4) Causes diseases to plant in soil.

(5) Some types of actinomycetes cause the diseases to animals and human.

(6) Play a role in antagonism and maintain in the governorate in balance in soil.

Algae

***Habitat:**

Algae found in different habitats:

On earth and water:

Many of algae are aquatic where found in freshwater (fresh water algae) and some of them found in marine water (Marine water algae).

-Some of algae live in terrestrial (terrestrial algae).

-Some of them live with different types of plants such as Endophytes, epiphytes and cryphophytes.

***General characters of algae:**

(1) Algae obtain through food requirements through the photosynthesis reaction where algae contain pigments such as chlorophyll

(2) Some of algae can live under soil and obtain their energy by oxidation of the organic matter and under suitable condition where they found light that can give energy for photosynthesis

(3) Algae can adapt with different changes in ecology where can resist many unsuitable conditions

(4) Algae are thallus plants

(5) Algae have numerous shapes such as unicellular thallus colonies, multicellular filamentous thallus (simple or branched) and leafy thallus.

***The importance of algae:**

(1) Algae are the main sources of food to aquatic animals.

(2) Algae play an importance role in the presence of large amount of oxygen in water and atmosphere.

(3) Algae are used in the purification of water from bacteria and other micro-organisms

(4) Some algae are beneficial to agriculture because they can maintain the fertility of the soil

(5) Some algae are used in many important industries such as agar-agar, antibiotic and fatty acid.

(6) Some algae secret some toxins which effect on other organisms in the field and some of them causes some diseases to other aquatic micro-organisms.

(7) Algae play a role in the maintance the structure of the soil.

(8) Algae play a role in fertilization of the soil in the fields of rice by increasing the nitrogen contents in the soil.

(9) Algae play a role in increasing the solidify of the soil.

(10) Some algae are parasites on some plants and causes some diseases.

(11)Some algae uses in the production of food to man.

(12) Some algae produce antibiotics which uses in treatment of some diseases.

(13) Some algae produce pigments which enter in many industries.

(14) Some algae uses as a source of iodden

(15) Some algae produce alginates (alginic acid) which play an important role in many industries.

***Classification of algae:**

- Classification of algae depends on :

(1) Type of pigments.

(2) Types of products which storage in the cells.

(3) Types of sex organs.

***Environmental factors affecting on the growth of algae.:**

(1) Light:

Light effect on the growth and spread of algae where the occurrence of light cause increasing in algae and the absence of light cause decreasing of algae.

(2) PH value :

Effect on the growth and spread of algae where the most of algae grow in PH =7 and some of algae can grow in acidity or alkaline medium.

(3) Humidity:

Effect on the growth and spread of algae where the low humidity cause decreasing in algae and high humidity cause increasing in the occurrence of algae.

(4) The using of herbicides:

Effect on the growth and spread of algae where it cause decreasing in the numbers and occurrence of algae.

(5) **Some micro-organisms which found in the soil also effect on** the growth and spread of algae by secretion of some enzymes that analyze the cell wall of algae.

Viruses

***Composition of viruses:**

Virus consists of DNA or RNA surrounded by protein sheath (capsid) and capsule (envelop)

***Habitat:**

Viruses are found in different habitats on the earth where living hosts such as human, plants and animals where the viruses are obligate parasite.

***General characters of viruses:**

(1) Viruses are able to grow and reproduce inside the cell or tissues of host after infection.

(2) Viruses depends on living cells in growth and reproduction.

(3) Viruses respond to the effect of the temperature.

(4) Viruses are able to produce mutation types.

(5) Viruses different in the parasitism on the host where they have specify in parasitism on the host but some of them have a host range in parasitism.

(6) Viruses have not a metabolic activity.

(7) Viruses are able to form crystals in test tubes.

- **The importance of viruses:**

(1) Viruses causes many of diseases to human, plant and animals.

(2) Viruses play a role in arrangement in the number density of insects.

Fungi

* Several techniques have been used to study the fungal flora. The most approach used for enumeration is the plant count. In which dilutions of soil specima in sterile water are plated on a suitable agar medium.

Population estimates of fungi based on plate counting are open to a serious criticism, since colonies appearing on the agar medium may be derived from spore or a fragment of vegetative mycelium the active or dormant nature of viable unite is unknown, the readily sporulating genera appear in large number ,for these and other reasons the results of plant counting must be interpreted with considerable care.

***Fungi may be investigated in a number of ways not involving soil dilution such as:**

(1) Microscopic observation.

(2) The rossi- cholodny buried slide.

(3) Observing fungi developing in agar which has been poured over and mixed with soil contained in petri dishes.

(4) Isolating organisms growing in an agar medium contained in perforated glass or plastic cylinders that have buried in the soil.

(5) Conventional plate counts have been most wide used since, although the results are far from univocal ,this procedure permits adegree of quantification.

*Estimates of microbial density reveal the presence in soil populations ranging from as few as 20.000 to as many as 1.000.000 fungal propagules per gram (propagule is any spore, hypha or hyphal fragment that is capable of giving rise to a coony)

* A variety of methods have been devised to assess the length of hyphae and total fungal biomass.

*Individual genera and species have been in diverse habitats listing are thus available for the inhabitant of peats, flooded soils planted to rice ,regions with low and extremely high salt contents. Locations in many deserts, sites in Antarctica ,as well as the tundra. The residents are frequently quite different but cosmopolitan genera are also in evidence in widely different ecosystems.

***Environmental influences**:

- The major external influences imposed on the fungus community include the organic matter status, hydrogen ion concentration, organic and inorganic fertilizers, the moisture regions , aeration, temperature, position in the profile, season of year and composition of the vegetation.

(1) **Organic matter status:**

- The numbers of filamentous fungi in soil any directly with the content of utilizable organic matter but this microbial group in still present and of importance in areas low inorganic matter.

-Improving the nutrient status by the incorporation of crop residues, green manures or other carbonaceous materials has the anticipated effect of increasing the size of community at the same time alters the composition of the flora.

-Certain species become abundant on addition of the carbon sources but their numbers rapidly decline following the initial increase.

- Other species maintain high population levels for long periods after incorporation of plant residues.

- The response varies with the chemical composition of the substrate and with certain environmental characteristics.

(2) Hydrogen ion concentration:

- Governs microbial activity and composition of the flora. Many species can develop over high range of PH from the highly acid to alkaline. The capacity to grow at PH values as low as 2 to 3 is not rare and numerous strains still active at PH=9 or above because the bacteria and

actinomycetes are uncommon in acid habitats, the microbial community in areas of low PH is dominated by fungi.

- PH sensitivity can be of profound importance to soil borne plant pathogens such as *plasmodiophora brassica* fare best in acid habitats, and the disease produced in land of PH greater than 7.5,other plant pathogens grow in soils near neutrality whereas certain species are prolific in alkaline localities.

(3) Organic and inorganic fertilizers:

- The application of inorganic fertilizers may modify the abundance of filamentous fungi, these alteration are frequently more the result of acidification than nutrient addition.

- Treatment with fertilizers containing ammonium salts increases numbers because microbial oxidation of nitrogen to nitric acid, and the repeated annual addition of ammonium fertilizers favors the fungal and diminishes bacterial and actinomycetes counts.

(4) Moisture:-

- Soil water has a direct effct upon the abundance and functions of fungi.

(a) - When water supply is low, their capacity for catalyzing chemical changes is poor or lacking entirely. Improvement in the moisture status of the environment favors the fungal numbers.

(b)-Fungi may persist in relatively semiarid conditions and they may be active into calities with low water content.

(c)- When moisture is excessive ,diffusion of the O2 necessary for aerobic metabolism is in adequate to meet the microbiological demand and fungi among the first are suffer .

(d)-Many genera are affected as water level increase but certain of the mucorales become more numerous.

(5)Temperature:-

(a)-Most species are mesophiles , and their mesophilic growth is un common.

(b)-A few thermophilic strains can be demonstrated in normal soil ,thermophiles will multiphy at 50C and some time at 55 C but not at 65 C and they are absent in composts that reach high temperature.

(c)- Organisms activity growing at about 37 C seem to be localized in the surface horizons.

(6) **Position in the profilie:-**

(a)- In cultivated soil, fungi are most numerous in the surface layers ,but high counts are observed in the horizon of grass sod.

(b)-The population remains large in the subsoil ,and it may be appreciable to a depth of more than one meter.

(c)- The organism concentration in the upper layers of the profile is to a large extent the result of available organic matter.

(7) **Season of year:-**

(a)-Exerts its influence in many ways.

(b)- Counts tend to be high in the autumn and spring and often decline during dry periods in the summer.

(**8) Type of vegetative cover:-**

(a)- Certain of the micro-organisms are associated with definite plant communities while others seem to be unaffected by the kind of vegetative.

(b)-In quantitative terms, for example fields cropped continuously to oats contain more fungi then land cropped continuously corn or wheat suggesting a selective action by oat plant.

(c)- Qualitatively, the predominant fungus under oats is *Aspergillus fumigatus* while *Penicillium funiculosum* is the most numerous under corn.

* **Activity and function:-**

(1) Fungi not contain chlorophyll ,hence they must obeain carbon for cell synthesis from performed organic molecules, among the carbon sources utilized are sugars, organic acids, dissacharides, starch, pectine etc.

(2) Fungi attack other soil micro-organisms such as protozoa.

(3) Degradation of complex molecules ,the rapid fungal response following the addition of mature plant residues, green tissues.

(4) Fungi are active in the formation of ammonium and simple nitrogen compounds in the process of decomposition of complex nitrogen containing molecules.

(5) Fungi participate in the formation of humans from fresh organic residues.

(6) Certain normally saprophytic species may ,at opportune occasion invade living_tissue and function as agents of plant disease.

-A unique_fungus associated with higher plants is found in the structure known as mycorrhiza or fungus root.

Mycorhizae

*** Mycorhizae is divided into** :

(1)Ectomycorhizae(ectotrophic)-(2)Endomycorhizae (endotrophic)-(3) Ectoendomycorhizae

* In the ectotrophic associated with the roots, the fungus forms a mantle around the exterior of the roots, it is formed the harteg net between cortex ,it formed composed of mass of hyphae entering into the spaces between individual plant cell such as many tree including some of economic importance, it is white or yellow colour.

* In endotrophic mycorhizae, the fungus penetrates the cell of the host and these associated with common among ericaceae and orchidaceae, not formation mantle but formed hustoria or vessls,it consists of little hyphae which formed zoospores and chlamydospores.

*Ectoendomycorhizae is formed from husetoria and harteg net ,grow inside and outside of the cortex and formed mantle.

* The formation of mycorhizae is pronounced in land low in phosphorus and nitrogen and high nutrient levels or correlated with poor mycorhizae development.

The production of mycorhizae is most vigorous when roots have alarge reserve of a vailable carbohydrates.

***The importance of mycorhizae:-**

(1)- Mycorhizae are important in forestry, involved as they are in problems of reforestation and in afforestation of new land.

(2)- The influence of mycorhizae on the uptake of inorganic nutrients.

(3)-Mycorhizae roots assimilate phosphate more readily than fungus free roots thus enabling the plant to grow well in phosphorus deficient land.

(4)-Uptake of nitrogen, sulfur, zinc and others essential elements.

(5)-The fungus protect the root against infection by a diverse of soil borne pathogens.

(6)-The plant help of mycorhizae in the growth through provided it with organic matter

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