

By: Aniket

## \* Nitrogen fixing microbes in agriculture \*

⇒ Nitrogen fixation is very important event in which atmospheric nitrogen fixed in the soil, which ultimately increase the fertility of soil.



⇒ The reduction of atmospheric gaseous nitrogen in ammonia is called  $N_2$ -fixation.



⇒ Nitrogen is very essential nutrients of living beings, which is required for synthesis of protein/amino acid/nucleic acids, etc.



⇒ The conversion of atmospheric inorganic nitrogen into organic nitrogen in plants take place by certain micro-organisms.

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## \* kinds of $N_2$ -fixation:

(1) Atmospheric- $N_2$ -fixation: The atmospheric nitrogen contains 79% nitrogen of total gas present in atmosphere, but majority of plants cannot get atmospheric-nitrogen.



⇒ In atmospheric nitrogen, lightning temperature in the atmosphere plays very important role in which atmospheric nitrogen converted into

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(ii) Biological nitrogen fixation: - when micro-organisms involve in the conversion of atmospheric nitrogen into inorganic nitrogen compound by living-organisms is called Biological- $N_2$ -fixation.



⇒ The  $N_2$ -fixation micro-organisms are found in 3 different forms:-

i) Autotrophic - Biological- $N_2$ -fixation: - It is aerobic-micro-organisms in the form of Blue green organisms, and anaerobic micro-organisms in the form of Rhodospirillum.



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(ii) Heterotrophic Biological  $N_2$ -fixation: - It is found in the form of aerobic micro-organisms.



Ex:- Azotobacter and it is also found in anaerobic form e.g. Clostridium.

(iii) Symbiotic Biological  $N_2$ -fixation: - The symbiotic bacteria in the form of rhizobium helps in  $N_2$ -fixation in root nodule of legumes, which fixes atmospheric  $N_2$  are called Amino-nitrogen nodule.



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⇒ The leguminous plant, whose root nodules are found  
i.e. Bean, Pea, Groundnut, pulses plant etc.

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⇒ The root nodule contain a pigment called leg. Haemoglobin, which is pink in colour, and it is closely related to Haemoglobin present in RBC.

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⇒ The symbiotic  $N_2$ -fixing micro-organism is not only in leguminous plant.

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⇒ It also contains some non-leguminous plant in  
Fornicia, alnus, myrica etc.

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⇒ The free living  $N_2$ -fixing micro-organism like Cyanobacteria and photosynthetic bacteria fix atmospheric nitrogen.

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Ex:- Azelle and roots of gymnosperm.

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✶ Mechanism of Biological  $N_2$ -fixation: The plant picks up nitrogen from the soil in the form of ammonium ions or nitrate ions.

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⇒ Ammonia is the main product of biological  $N_2$ -fixation.

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⇒ It is converted to nitrate by number of soil bacteria.

⇓  
⇒ There are different event taking place during biological  $N_2$  fixation.

⇓  
⇒ The conversion of atmospheric nitrogen into inorganic organic usable form in the presence of living being is called "Biological- $N_2$ -fixation".

⇓  
⇒ The process of biological  $N_2$ -fixation take's place by 2 main types of micro-organism:-

i.) free living asymptotic micro-organism

ii.) Symbiotic micro-organism

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1.) free living asymptotic micro-organism:- There are large number of free living bacteria and cyanobacteria which fix atmospheric nitrogen into usable form.

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⇒ These micro-organism can be categories as follows:-

a.) free-living aerobic  $N_2$ -fixing bacteria:- Ex:- Azotobacter.

b.) free-living anaerobic  $N_2$ -fixing bacteria:- Ex:- Clostridium

c.) free living photoautotrophic  $N_2$  fixing bacteria:- Ex:- Rhodospirillum

d.) free living chemosynthetic  $N_2$ -fixing bacteria:- Disulphobium

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i) Free-living  $N_2$ -fixing cyanobacteria: - Large no. of heterocysts of cyanobacteria or B.A.N.

ii) Symbiotic micro-organism: - Many bacteria and cyanobacteria fix atmospheric  $N_2$  in its symbiotic association with other plants are called "Symbiotic  $N_2$  fixation".

Ex: - i) Rhizobium in association with roots of leguminous plant.

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ii) Anthocyanus (Bryophytes): - In association with nostoc.

iii) Azolla (hectoterran): - In association with Anabena-Azolla.

iv) Coralloid group of cycas in association with Anabena and nostoc.

Mechanism of  $N_2$ -fixation in leguminous plant: -

⇒ Rhizobium is the most important  $N_2$  fixing bacteria which fixes atmospheric  $N_2$  in symbiotic association with root of leguminous plant (Peas, bean etc.)

⇒ Initially bacteria grows in the soil near the root of higher plant where it fail to fix  $N_2$ .

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⇒ The bacteria comes in contact with the root of leguminous plant and it interacts chemically then enters into roots through root-hair.

⇒ The entry of bacteria into root hair depends upon various chemicals which is release from root hairs.

⇒ The root-hair forming thread like structure called "infection thread".

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⇒ The bacteria multiply when it enters through the infection thread.

⇒ Finally bacteria reaches upto cortex, where they enters into the cell and stimulates the cell for division.

⇒ The specific cell where bacteria grows and divide rapidly forming root nodules which contain several thousand bacteria.

⇒ In the cytoplasm of nodule, cell filled with red pigment called leg. Haemoglobin which has ability to combine rapidly with  $O_2$  that's why it is called "oxygen scavenger".