



BIOFERTILIZER

Dr. Rahul Adhikary

- 
- A biofertilizer is a substance or term which contains living microorganisms , can applied with seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.
 - Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances.

whY..?

- **Fertilizers** supply essential plant nutrients, mainly Nitrogen(N), Potash (K) and Phosphorous (P) as they are removed in large quantities from the soil by each successive harvest. Increasingly high inputs of chemical fertilizers for high yield agriculture during the last 150 years has not only left our soils degraded, polluted and less productive but also posed severe health hazards.
- Further increase in food production will depend on either increasing the productivity of existing areas or by bringing additional lands, presently under fallow or wasteland categories, under cultivation.
- **bio-fertilizers** have the potential to play a major role in making agriculture a viable proposition here.

IMPORTANCE In AGRICULTURE...

- Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides.
- The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter.
- Through the use of bio-fertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil.
- They are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements.
- bio-fertilizers do not contain any chemicals which are harmful to the living soil.

- Bio-fertilizers such as Rhizobium, Azotobacter, Azospirillum and blue green algae (BGA) have been in use a long time.
- Azotobacter can be used with crops like wheat, maize, mustard, cotton, potato and other vegetable crops. Azospirillum inoculations are recommended mainly for sorghum, millets, maize, sugarcane and wheat.
- *Nostoc* or *Anabaena* [blue green algae], fix atmospheric nitrogen and are used as inoculations for paddy crop grown both under upland and low-land conditions.
- phosphate-solubilizing bacteria - Pseudomonas (P13), are able to solubilize the insoluble phosphate from organic and inorganic phosphate sources

Types Of Biofertilizers

6 types :

- Rhizobium
- Azotobacter
- Azospirillum
- BGA
- Azolla
- Phosphate solubilizing microbes



A simple form of classification of biofertilizers is given below:

1) For Nitrogen

- ▶ Rhizobium for legume crops.
- ▶ Azotobacter / Azospirillum for non legume crops.
- ▶ Blue -Green Algae (BGA) and Azolla for low land paddy.

2) For Phosphorous

- ▶ Phosphatika for all crops to be applied with Rhizobium, Azotobacter,
- ▶ VAM(Vesicular-arbuscular mycorrhiza).

3) For Enriched Compost

- ▶ Cellulolytic fungal culture.
- ▶ Phosphatika and Azotobacter culture

Types of bio fertilizer

Nitrogen Fixing Biofertilizers

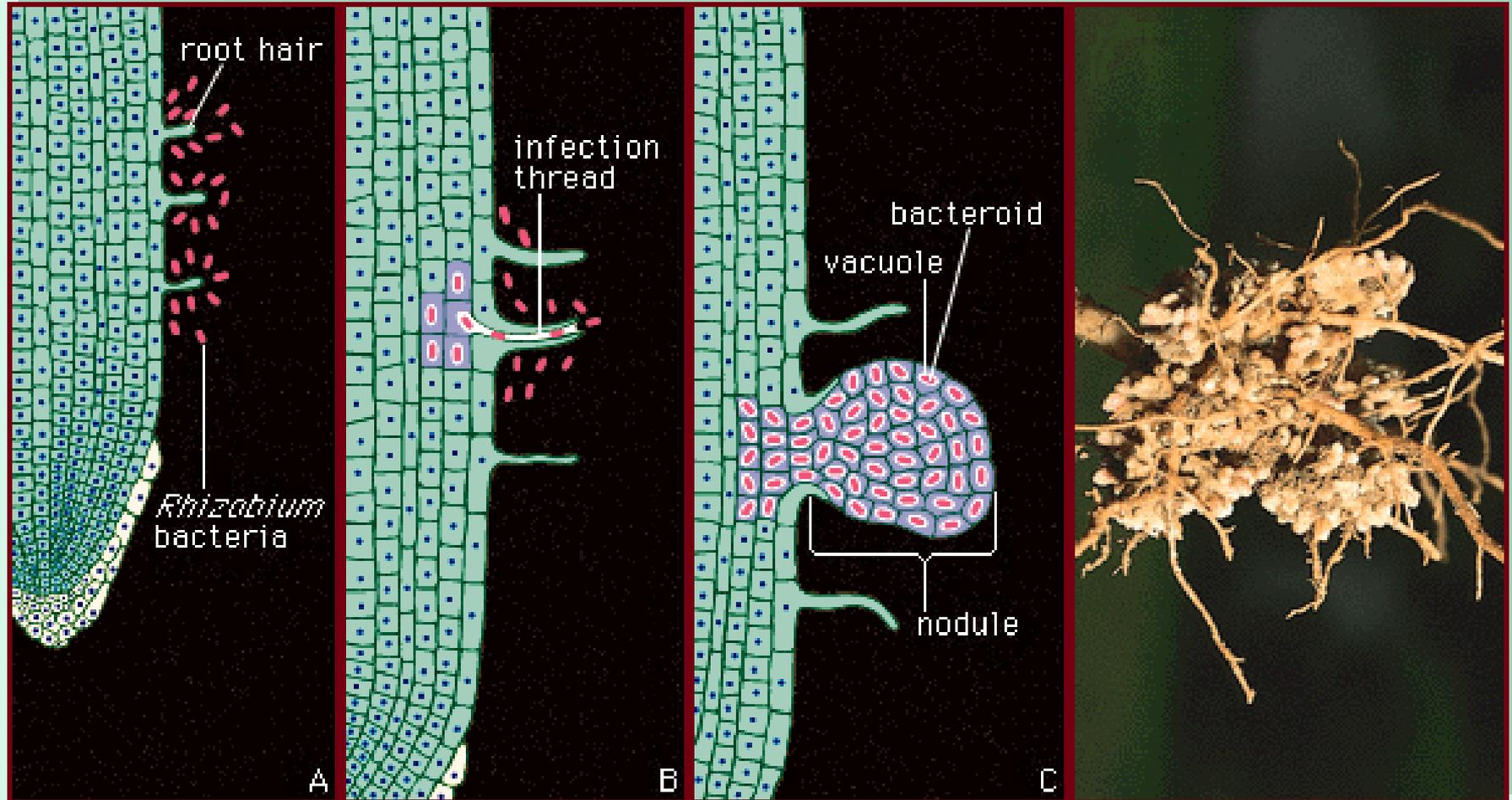
- The nitrogen fixing bacteria work under two conditions, symbiotically and free living bacteria (non-symbiotic).
- The symbiotic bacteria make an association with crop plants through forming nodules in their roots.
- The free living bacteria do not form any association but live freely and fix atmospheric nitrogen.

RHIZOBIUM

- Gram negative, motile, non-sporulating rods.
- Forms root nodules in leguminous plants & fix atmospheric N₂ in a symbiotic association

- 
- Legumes: Peas, beans, clover, and soy
 - Rhizobia enter a root hair and travel down to tube relatively anoxic centre of the root hair cell.
 - Here, proliferating plant cells form a nodule.
 - Fixes N_2 from atmosphere into a plant usable form, ammonium (NH_4^+),
 - Plant supplies carbohydrates, proteins, sufficient O_2 ,

Rhizobium Root Nodules



Phosphate-solubilizing Microbes:

- Phosphorus, important nutrient for plants
- Microbes that can solubilize the cheaper sources of P – as rock phosphate.
 - Bacteria – *Pseudomonas striata* & *Bacillus megaterium*
 - Fungi – *Aspergillus* & *Penicillium*
- Also, releases soluble P into soil through decomposition of phosphate-rich organic compounds.

Mycorrhizae

- Refers to fungus associated with plant roots.
- 2 types:
 - Ectotrophic and
 - Endotrophic

- 
- Important for adequate uptake of immobile ions such as phosphate, zinc and micronutrients.
 - Stimulates branching of the root.
 - Increases the absorption surface of the root.
 - Tolerance to drought, high soil temperature, soil toxins, and extreme pH levels.
 - Protection against root pathogens

Azospirillum

- Nitrogen-fixing bacteria that lives in a symbiotic relationship in the root cortex of several tropical crops
- Stimulate plant growth through N₂ fixation
- Helps in production of growth substances like auxins, gibberellins .
- 10-15% of the required N₂ is met by Azospirillum biofertilizer.

Azotobacter

- Free-living, N₂-fixing bacteria.
- Produces several plant growth promoting substances.
- Protects plants against pathogenic microbes either by discouraging their growth or by destroying them.

Blue Green Algae

- or Cyanobacteria
- Can carry out both photosynthesis as well as N₂ fixation
- Algal flakes are grown & then broadcasted.

Blue Green Algae (BGA)

- The Blue-green algae are small organisms and can be seen under the microscope as a single cell.
- They have a similar external appearance to that of **Algae** and **Azolla growing in a pond** their requirements for light, nutrients and carbon dioxide are also similar.

Azolla



BLUE GREEN ALGAE



Method of biofertilizer inoculation

• *Seed Inoculation*

- This is the most common practice of applying biofertilizers.
- In this method, the biofertilizers are mixed with 10 per cent solution of jaggary.
- The slurry is then poured over the seeds spread on a cemented floor and mixed properly in a way that a thin layer is formed around the seeds.
- The treated seeds should be dried in the shade overnight and then they should be used.
- Generally, 750 gram of biofertilizer is required to treat the legume seeds for one hectare area.

Soil Application

- This method is mostly *used* for fruit crops, sugarcane, and other crops where localized application is needed.
- At the time of planting of fruit trees, 20 g of biofertilizer mixed with compost is to be added in the ring of one sapling.
- Sometime, the biofertilizers are also *broadcasted* in the soil but we may require four to ten times more bio fertilizers.
- Before broadcasting, the inoculants should be incubated with the desired amount of well decomposed granulated FYM for 24 hours.

Self Inoculation

- This method is suitable for application of Azotobacter. In this method, 50 litres of water is taken in a drum and 4-5 kg of Azotobacter biofertilizer is added and mixed properly.
- Planting materials required for one acre of land are dipped in this mixture.
- Similarly, if we are treating the potato, then the tubers are dipped in the mixture and planting is done after drying the materials in the shade

ADVANTAGES

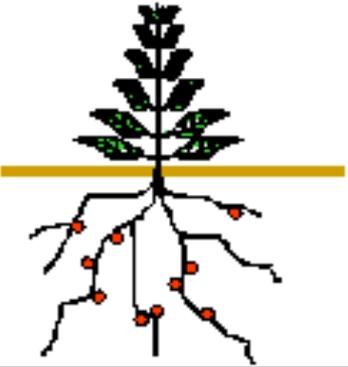
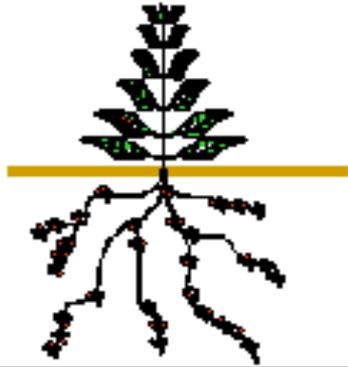
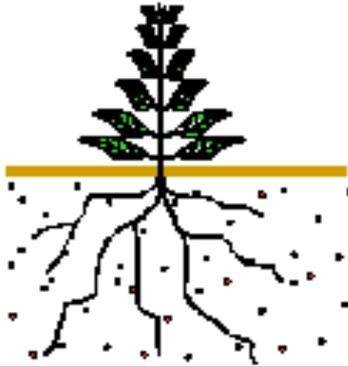
- There are many advantages of using the biofertilizers. They form an important *association with other soil microbes and help in nutrient supply.*
- Fixes atmospheric nitrogen.
- Increase availability or uptake of nutrients through solubilization or increased absorption.
- *Stimulate plant growth* through hormonal or antibiotics action or by decomposing organic waste.
- They are cheap, hence, reduced cost of cultivation.
- *Improves soil properties* and sustaining soil fertilityLead to soil enrichment.
- compatible with long term sustainability.
- *Build up soil fertility in the long term.*
- They are eco-friendly and pose no damage to the environment

Why biofertilizers are not so popular?

In spite of several long lasting benefits the bio-inoculants are not very popular among the farming community. There may be several reasons for this, however some of the important ones are as given below:

- **Nutrient contribution is dependent on survival of organisms.**
- Soil with high nutrient status do not show instant visible benefits.
- **Low carbon content of soils-**
- **Water scarcity** -possibility of desiccation.
- **Fluctuating soil pH-** variable microflora.
- **Extreme temperature** -in summer months.
- **Poor storage** and transportation
- Lack of awareness.

Ecology of nitrogen-fixing bacteria

<p>System of N₂ fixation</p> <p>(and microbes involved)</p> <p>(N₂ → NH₃)</p>	<p>SYMBIOSIS (e.g. <i>Rhizobium</i>)</p> 	<p>ASSOCIATION (e.g. <i>Azospirillum</i>)</p> 	<p>FREE-LIVING (e.g. <i>Rhodospirillum</i>)</p> 
<p>Energy source (Organic C)</p>	<p>Sucrose from the host plant</p>	<p>Root exudates from the host plant</p>	<p>Heterotroph (plant residues) Autotroph (photosynthesis)</p>
<p>Estimates of fixation rate (kg N/ha/y)</p>	<p>50-400</p>	<p>10-200</p>	<p>1-2 10-80</p>

Benefits

- Since a bio-fertilizer is technically living, it can symbiotically associate with plant roots. Involved microorganisms could readily and safely convert complex organic material in simple compounds, so that plants are easily taken up.
- Microorganism function is in long duration, causing improvement of the soil fertility.
- It maintains the natural habitat of the soil.
- It increases crop yield by 20-30%,
- replaces chemical nitrogen and phosphorus by 25%, and stimulates plant growth.
- It provide protection against drought and some soil-borne diseases.
- Bio-fertilizers are cost-effective relative to chemical fertilizers.
- It is environmentally friendly in that it not only prevents damaging the natural source but also helps to some extent cleanse the plant from precipitated chemical fertilizers.



AZOLLA FRONDS FREELY FLOATING IN CULTURE MEDIA



STAGE-1.

STAGE-2.

STAGE-3.

STAGE-4.

STAGE-5.

VARIOUS STAGES IN THE FORMATION OF THE DENSE AZOLLA MAT.

A profile of different biofertilizers

Biofertilizer	Function/Contribution	Limitation	Target Crops
Rhizobium	Fixation of 50-100 kg N/ha 10-35% increase in yield, leaves residual N	Fixation only with legumes, Visible effect not reflected in traditional area, Needs optimum P , Mo	Pulse Legumes Oilseed Legumes Forage legumes Tree legumes
Azotobacter	Fixation of 20-25 kg N/ha 10-15% increase in yield, Production of growth Promoting substances	<u>Demands high organic matter</u>	Wheat, maize, cotton, mustard, vegetable crops
Azospirillum	Same	<u>Poor performance in winter crops</u>	Sorghum. Pearl millet minor millets, maize, rice sugarcane
Blue Green Algae and Azolla	Fixation of 20-30 kg N/ha (BGA):- 30-100kg N/ha F (Azolla) 10-15% increase in yield	Effective only in submerged rice Demands bright sunlight Survival difficult at high temp.	Flooded rice
Phosphate Solubilisers	5-50% increase in yield	-	All crops



Thank You

