

Biofertilizers PYQ 2020

Q1. Write in detail the procedure of isolation and mass multiplication of Azotobacter and its role in agriculture.

Ans. Isolation and Mass Multiplication of Azotobacter and Its Role in Agriculture:

Azotobacter is a nitrogen-fixing bacterium that plays a vital role in agriculture by converting atmospheric nitrogen into a form that plants can readily absorb. This reduces the need for synthetic nitrogen fertilizers and promotes sustainable agriculture. **To isolate and mass multiply Azotobacter, follow these steps:**

Isolation of Azotobacter:

- 1. Sample Collection:** Collect soil samples from agricultural fields or other environments with high organic matter content. Azotobacter is commonly found in such soils.
- 2. Serial Dilution:** In the laboratory, serially dilute the soil samples using sterile saline solution (0.85% NaCl). This dilution is essential to obtain pure cultures.
- 3. Inoculation:** Transfer a small volume of each dilution onto a suitable growth medium like Ashby's agar or Azotobacter agar. These media contain nutrients that promote the growth of Azotobacter.
- 4. Incubation:** Incubate the agar plates at a suitable temperature (usually around 28-30°C) for several days. Azotobacter colonies should appear as white or cream-colored, shiny, and mucoid colonies.
- 5. Sub-culturing:** Select pure colonies and streak them onto fresh agar plates to obtain pure cultures of Azotobacter. Repeat this process as necessary to ensure purity.

Mass Multiplication of Azotobacter:

- 1. Preparation of Inoculum:** Start by preparing an inoculum of Azotobacter. This can be done by transferring a pure culture of Azotobacter to a nutrient-rich broth medium, such as Ashby's broth or glucose yeast extract broth. Allow the culture to grow for 24-48 hours until it reaches the exponential phase.
- 2. Scaling Up:** Once you have a healthy culture, you can scale up the production. Depending on the scale, you can use flasks, bioreactors, or fermenters.
- 3. Fermentation:** In a controlled environment, provide the necessary conditions for Azotobacter growth. This includes maintaining optimal temperature (around 28-30°C), pH (around 7.0), and oxygen levels (aerobic conditions). Stirring or agitation may also be necessary to ensure proper aeration.
- 4. Harvesting:** After the culture has reached its maximum growth phase, harvest the Azotobacter cells. This can be done by centrifugation or filtration to separate the bacterial cells from the growth medium.
- 5. Formulation:** The harvested Azotobacter cells can be formulated into various products, such as liquid suspensions, powders, or granules. These formulations make it easier to store and apply Azotobacter to agricultural fields.

Role of Azotobacter in Agriculture:

Azotobacter has several crucial roles in agriculture:

- 1. Nitrogen Fixation:** Azotobacter is a nitrogen-fixing bacterium, which means it can convert atmospheric nitrogen (N₂) into ammonia (NH₃) or other organic nitrogen compounds that plants can utilize as a nitrogen source. This reduces the need for synthetic nitrogen fertilizers.
- 2. Plant Growth Promotion:** Azotobacter also produces growth-promoting substances like auxins, gibberellins, and vitamins, which enhance plant growth and development.
- 3. Improved Soil Structure:** The mucilaginous substances produced by Azotobacter help improve soil structure, making it more conducive to root growth and water retention.
- 4. Disease Suppression:** Some strains of Azotobacter produce antibiotics that can suppress the growth of plant pathogens, thus contributing to disease control in agricultural systems.
- 5. Environmental Sustainability:** The use of Azotobacter as a biofertilizer reduces the environmental impact associated with the production and use of synthetic nitrogen fertilizers, helping to promote sustainable agriculture.

Overall, Azotobacter plays a significant role in enhancing soil fertility, plant growth, and reducing the environmental footprint of agriculture. Isolating and mass multiplying Azotobacter allows for its effective application in agricultural practices, ultimately leading to more sustainable and productive farming.

Q2. What is "compost"? How will use of compost in agriculture help in maintaining soil health? Elaborate any one composting method.

Ans. Compost is a nutrient-rich organic material that is created through the decomposition of organic matter. It is a valuable resource in agriculture and gardening because it can be used to enhance soil health, improve soil structure, and provide essential nutrients to plants. Compost is created through a natural biological process known as composting, where microorganisms break down organic materials into a humus-like substance.

The Use of Compost in Agriculture for Maintaining Soil Health:

Using compost in agriculture offers several benefits for maintaining soil health:

- 1. Nutrient Enrichment:** Compost is a rich source of essential plant nutrients such as nitrogen, phosphorus, and potassium, as well as secondary and micronutrients. When incorporated into the soil, compost slowly releases these nutrients over time, providing a steady and balanced supply to plants.
- 2. Improved Soil Structure:** Compost contains organic matter that helps improve soil structure. It enhances soil's ability to retain moisture, which is especially beneficial in sandy soils, while also promoting drainage in clay soils. This improved structure makes it easier for plant roots to penetrate the soil, access nutrients, and grow vigorously.
- 3. Microbial Activity:** Compost introduces beneficial microorganisms to the soil, including bacteria, fungi, and earthworms. These microorganisms contribute to nutrient cycling, disease suppression, and the breakdown of organic matter, further improving soil health.
- 4. pH Regulation:** Compost can help buffer soil pH, making it more suitable for plant growth. It tends to move soil pH closer to a neutral range, which is favorable for most crops.
- 5. Reduced Erosion:** The improved soil structure and increased organic matter content resulting from compost application reduce soil erosion by enhancing soil stability.

Composting Method: Windrow Composting

Windrow composting is a widely used composting method that can be carried out on a small to large scale, making it suitable for both home gardeners and commercial agriculture. **Here's how windrow composting works:**

Materials Needed:

Organic Waste: Gather a mixture of organic materials, including kitchen scraps, yard waste, crop residues, and manure. Ensure a balance of green materials (rich in nitrogen) and brown materials (rich in carbon) to maintain the right carbon-to-nitrogen (C:N) ratio.

Aeration: You'll need a space or container where you can create long, narrow piles of compost materials called windrows. Good aeration is essential for the composting process.

Steps:

1. **Layering:** Start by layering the green and brown organic materials in the windrow. Each layer should be moistened as you build it, but avoid making it too wet, as excessive moisture can impede the composting process.
2. **Turning:** Regularly turn the windrows using a pitchfork or specialized compost turner. Turning aerates the compost, ensuring that oxygen is available for the microbial decomposition process. The frequency of turning depends on factors like temperature, moisture, and the type of materials used but is usually done every few weeks.
3. **Monitoring:** Monitor the compost temperature using a thermometer. Ideal composting temperatures range between 120°F to 160°F (49°C to 71°C). This range helps kill weed seeds and pathogens while promoting the breakdown of organic matter.
4. **Maturation:** Compost can take several months to a year or more to fully mature, depending on factors such as the size of the windrow, the materials used, and the environmental conditions. The compost is ready when it appears dark, crumbly, and has a rich earthy smell.
5. **Application:** Once the compost is mature, it can be incorporated into the soil before planting or used as a top dressing for established plants. It's essential to ensure that the compost is fully decomposed to avoid nutrient immobilization or potential phytotoxicity.

Windrow composting is an effective method for converting organic waste into valuable compost that can be used to improve soil health and enhance crop productivity in agriculture.

Q3. What do you understand by mycorrhizae? Discuss the major types of mycorrhizal association in detail. Explain with well labelled diagrams.

Ans. Mycorrhizae (singular: mycorrhiza) are mutually beneficial associations between certain fungi and the roots of most vascular plants. These symbiotic relationships play a crucial role in plant health and ecosystem functioning. Mycorrhizal fungi colonize the root systems of plants, forming specialized structures that facilitate the exchange of nutrients between the plant and the fungus. The fungi receive carbohydrates (sugars) from the plant, while the plant benefits from improved nutrient uptake, particularly in acquiring phosphorus and other minerals from the soil. There are several major types of mycorrhizal associations, including endomycorrhizae and ectomycorrhizae.

Major Types of Mycorrhizal Associations:

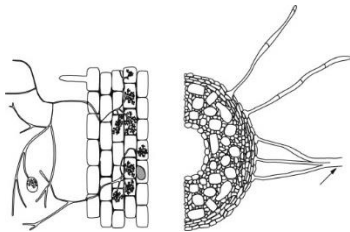
Endomycorrhizae (Endomycorrhizal Associations):

Endomycorrhizal associations, also known as arbuscular mycorrhizae (AM), are the most common type of mycorrhizal symbiosis. These associations involve fungi from the phylum Glomeromycota and are typically found in a wide range of plants, including most agricultural crops.

Key Features:

- 1. Fungal Hyphae Penetration:** In endomycorrhizae, the fungal hyphae penetrate the root cells of the host plant, forming structures known as arbuscules and vesicles within the root cortex.
- 2. Mutualistic Exchange:** Inside the root cells, the plant provides the fungus with carbohydrates produced through photosynthesis. In return, the fungus enhances the plant's ability to absorb water and nutrients, particularly phosphorus, from the soil.
- 3. Improved Nutrient Uptake:** The extensive fungal hyphal network effectively increases the root's surface area, allowing for greater nutrient absorption. This is especially important in nutrient-poor soils.

Diagram of Endomycorrhizal Association:



Endomycorrhizal Association Diagram

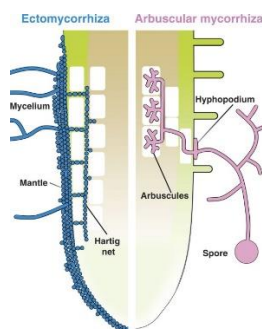
Ectomycorrhizae (Ectomycorrhizal Associations):

Ectomycorrhizal associations involve a different group of fungi, mainly belonging to the phyla Basidiomycota and Ascomycota. These associations are typically found in trees and woody shrubs, such as conifers and many hardwood species.

Key Features:

- 1. Fungal Sheath:** In ectomycorrhizae, the fungal mycelium forms a sheath around the outside of the root tips but does not penetrate the root cells themselves.
- 2. Hyphal Network:** The fungal hyphae create an extensive network in the surrounding soil, enhancing nutrient uptake and water absorption for the plant.
- 3. Improved Tolerance:** Ectomycorrhizal associations can confer resistance to root pathogens and improve the plant's tolerance to various environmental stresses.

Diagram of Ectomycorrhizal Association:



Ectomycorrhizal Association Diagram

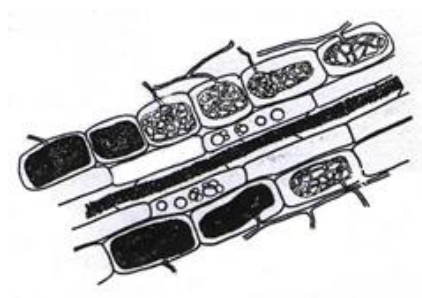
Ericoid Mycorrhizae:

Ericoid mycorrhizae are specialized mycorrhizal associations that are primarily found in plants from the Ericaceae family, which includes heather, blueberries, and rhododendrons. These associations involve fungi from various phyla, including Ascomycota and Basidiomycota.

Key Features:

1. **Fungal Hyphae:** In ericoid mycorrhizae, fungal hyphae penetrate the root cells, similar to endomycorrhizal associations.
2. **Nutrient Acquisition:** These associations are particularly adapted to acquiring nutrients from acidic and nutrient-poor soils, such as those found in heathlands and peat bogs.
3. **Improved Phosphorus Uptake:** Ericoid mycorrhizae are efficient at extracting phosphorus from the soil, making it available to the host plant.

Diagram of Ericoid Mycorrhizal Association:



Ericoid Mycorrhizal Association Diagram

In summary, mycorrhizal associations are essential symbiotic relationships between fungi and plants that significantly benefit both partners. These associations enhance nutrient uptake, improve plant growth, and play a vital role in maintaining ecosystem health. The specific type of mycorrhizal association formed depends on the fungal and plant species involved, as well as environmental factors such as soil conditions and plant types.

Q4. Define organic farming. Mention its key characteristics. What are its advantages and disadvantages?

Ans. Organic farming is a sustainable agricultural system that emphasizes the use of natural processes and resources to produce crops and raise livestock. It is a holistic approach to farming that aims to minimize the use of synthetic chemicals, genetically modified organisms (GMOs), and other artificial inputs while promoting environmental sustainability, animal welfare, and human health. Organic farming relies on ecological processes, biodiversity, and nutrient cycling to maintain soil fertility and crop health.

Key Characteristics of Organic Farming:

1. **Prohibition of Synthetic Inputs:** Organic farming prohibits the use of synthetic pesticides, herbicides, and fertilizers. Instead, it emphasizes natural methods for pest control and nutrient management.
2. **Crop Rotation and Polyculture:** Organic farmers often use crop rotation and polyculture (growing multiple crops together) to enhance soil fertility and reduce the risk of pests and diseases.
3. **Soil Health:** Organic farming places a strong emphasis on soil health. Practices such as composting, cover cropping, and reduced tillage are used to improve soil structure, increase organic matter content, and promote beneficial soil microorganisms.
4. **Animal Welfare:** Organic livestock farming standards require animals to be raised in conditions that prioritize their well-being, including access to outdoor areas, space to move around, and organic feed.
5. **Non-GMO:** Organic farming prohibits the use of genetically modified organisms (GMOs) in both crop production and livestock feed.
6. **Chemical-Free Post-Harvest Handling:** Organic standards require that organic produce be handled and processed without the use of synthetic chemicals, additives, or preservatives.

Advantages of Organic Farming:

1. **Environmental Benefits:** Organic farming reduces the use of synthetic chemicals, which can have negative impacts on the environment, including water pollution and harm to non-target species. It also promotes biodiversity and supports natural ecosystems.
2. **Healthier Food:** Organic produce is often perceived as healthier because it contains fewer pesticide residues. Some studies suggest that organic foods may have higher nutrient content.
3. **Soil Health:** Organic farming practices enhance soil fertility and structure, making it more resilient to erosion and better at retaining water.
4. **Reduced Antibiotic Use:** Organic livestock farming typically restricts the use of antibiotics, helping to mitigate the development of antibiotic-resistant bacteria.
5. **Support for Local and Small-Scale Farming:** Organic farming can empower local and small-scale farmers, as it often relies on diversified and decentralized production systems.

Disadvantages of Organic Farming:

1. **Lower Yields:** Organic farming often yields lower crop yields compared to conventional farming methods, which can lead to higher prices for organic products.
2. **Land Use:** Organic farming typically requires more land to produce the same amount of food as conventional farming due to lower yields.
3. **Cost:** Organic farming can be more expensive to implement due to the use of labor-intensive practices and the cost of organic certification.
4. **Pest and Disease Management:** Organic farmers rely on natural methods for pest and disease management, which may not always be as effective as synthetic chemicals.
5. **Transition Period:** Converting a conventional farm to organic practices typically requires a transition period during which the land is managed according to organic standards but cannot yet be certified as organic.
6. **Market Challenges:** Organic farmers may face market challenges, including price fluctuations and competition from larger conventional operations.

In conclusion, organic farming is an agricultural approach that prioritizes sustainability, environmental conservation, and human health. While it offers several advantages in terms of reduced environmental impact and healthier food options, it also faces challenges related to lower

yields, higher costs, and market dynamics. The choice to adopt organic farming practices depends on various factors, including a farmer's goals, available resources, and market demand.

Q5. What are the characteristics of blue green algae? Explain its role in rice cultivation.

Ans. Blue-green algae, also known as cyanobacteria, are a group of photosynthetic bacteria that have several distinct characteristics:

- 1. Color:** Blue-green algae are called "blue-green" due to their characteristic bluish-green color. This coloration is due to the presence of pigments such as chlorophyll a and phycocyanin.
- 2. Prokaryotic:** Unlike true algae, which are eukaryotic organisms, blue-green algae are prokaryotic, meaning they lack a true nucleus and other membrane-bound organelles.
- 3. Photosynthesis:** Blue-green algae are photosynthetic organisms capable of capturing energy from sunlight and converting carbon dioxide into organic compounds, just like plants.
- 4. Aquatic Habitat:** They are primarily found in aquatic environments such as freshwater lakes, rivers, ponds, and even in moist soil. Some blue-green algae can thrive in extreme conditions, including hot springs and deserts.
- 5. Ability to Fix Nitrogen:** One of the most important characteristics of blue-green algae is their ability to fix atmospheric nitrogen into a form that can be used by plants. This is achieved through specialized cells called heterocysts, which convert nitrogen gas (N_2) into ammonia (NH_3). This process is known as nitrogen fixation.

Role of Blue-Green Algae in Rice Cultivation:

Blue-green algae, particularly species like *Anabaena* and *Nostoc*, play a significant role in rice cultivation, especially in flooded rice fields. **Here's how they contribute to rice farming:**

- 1. Nitrogen Fixation:** Blue-green algae are natural nitrogen-fixing agents. In flooded rice paddies, the anaerobic (low-oxygen) conditions inhibit the activity of nitrogen-fixing bacteria in the soil. However, blue-green algae can thrive in these conditions and perform nitrogen fixation. They convert atmospheric nitrogen into ammonia, which is a form of nitrogen that rice plants can readily absorb. This reduces the need for synthetic nitrogen fertilizers, making rice cultivation more sustainable and cost-effective.
- 2. Increased Rice Yield:** The nitrogen-fixing ability of blue-green algae enhances the nitrogen supply to rice plants, leading to increased crop yields. This is especially important in areas with low soil fertility.
- 3. Improved Soil Health:** Blue-green algae contribute organic matter to the soil as they die and decompose. This organic matter improves soil structure, water retention, and microbial activity, leading to overall better soil health.
- 4. Pest Suppression:** Some blue-green algae produce natural compounds that can suppress the growth of certain rice pests and pathogens, providing a level of natural pest control.
- 5. Algal Mats as Green Manure:** In some traditional rice cultivation practices, farmers deliberately encourage the growth of blue-green algae in their rice fields. After the rice crop is harvested, these

algal mats are incorporated into the soil as green manure, enriching the soil with organic matter and nutrients for the next crop.

However, it's important to note that excessive growth of blue-green algae, often referred to as algal blooms, can have negative consequences, such as oxygen depletion in water bodies and the release of toxins harmful to aquatic life and human health. Therefore, proper management and control of blue-green algae populations in rice fields are essential to maximize their benefits while minimizing potential drawbacks.

Q6. Comment on the statement "Biofertilizer for sustainable agriculture".

Ans. The statement "Biofertilizer for sustainable agriculture" accurately reflects the significant role that biofertilizers play in promoting sustainability in modern agricultural practices. Biofertilizers are natural or organic products that contain beneficial microorganisms, such as bacteria, fungi, or algae, which facilitate nutrient cycling, improve soil health, and enhance plant growth. **Here's why biofertilizers are essential for sustainable agriculture:**

- 1. Enhanced Nutrient Availability:** Biofertilizers contain microorganisms that can fix atmospheric nitrogen, solubilize phosphorus, and mobilize other essential nutrients in the soil. This helps increase the availability of nutrients to plants, reducing the need for synthetic chemical fertilizers.
- 2. Reduced Chemical Dependency:** By promoting nutrient availability through biological processes, biofertilizers can reduce the reliance on synthetic chemical fertilizers. This leads to a decrease in the environmental pollution caused by nutrient runoff and minimizes the negative impacts of excessive fertilizer use on ecosystems.
- 3. Improved Soil Health:** Biofertilizers contribute to the improvement of soil structure, microbial diversity, and organic matter content. They enhance soil fertility, water retention, and nutrient-holding capacity, making soil more resilient and better suited for sustainable crop production.
- 4. Symbiotic Relationships:** Some biofertilizers, such as mycorrhizal fungi and rhizobium bacteria, form symbiotic relationships with plants. These associations enhance plant nutrient uptake and tolerance to environmental stressors, resulting in healthier and more resilient crops.
- 5. Economic Benefits:** Biofertilizers can be cost-effective in the long term. Although their initial application might not show immediate results compared to chemical fertilizers, over time, they contribute to improved soil fertility, reduced input costs, and increased crop yields.
- 6. Reduction of Greenhouse Gas Emissions:** Organic farming practices, including the use of biofertilizers, can help sequester carbon in the soil and reduce greenhouse gas emissions associated with synthetic fertilizer production and application.
- 7. Sustainable Food Production:** As the global population continues to grow, sustainable agriculture practices are essential to ensure food security. Biofertilizers support sustainable food production by reducing the environmental impact of agriculture while maintaining or even enhancing crop productivity.

However, it's important to note that the effectiveness of biofertilizers can vary depending on factors such as soil type, climate, crop type, and the specific microorganisms used. Proper management practices and the selection of appropriate biofertilizers for specific agricultural systems are crucial for maximizing their benefits.

In conclusion, biofertilizers are a valuable component of sustainable agriculture. They promote environmentally friendly and economically viable farming practices, reduce the negative impacts of chemical fertilizers, and contribute to the long-term health and productivity of agricultural ecosystems. Incorporating biofertilizers into agricultural systems is a crucial step towards achieving sustainable and resilient food production systems.

UniNotes.in