# Cyanobacteria and *Azolla*

1. **What do you mean by Cyanobacteria?**

   Cyanobacteria are a phylum of prokaryotes that are aquatic, free living and photosynthetic bacteria. The term cyanobacteria is a Greek word comes from their color, giving other name 'blue green algae' though some modern botanists restrict the term 'algae' to eukaryotes. They are quite small and usually unicellular, though they often grow in colonies.

2. **What is the role of Cyanobacteria in agriculture?**

   Cyanobacterium manages soil nutrition by fixing atmospheric nitrogen into the soil and also produces organic substances to the soil.

3. **Write some example of Cyanobacteria.**

   Fresh water – *Anabaena, Rivularia, Sytonema, Ocillatoria.*

   Sea water – *Dermocarpus, Trichodesmium*.

   Damp soil – *Anabaena, Nostoc, Ocillatoria.*

   Hot springs – *Croococcus, Microcystis, Phomidium.*

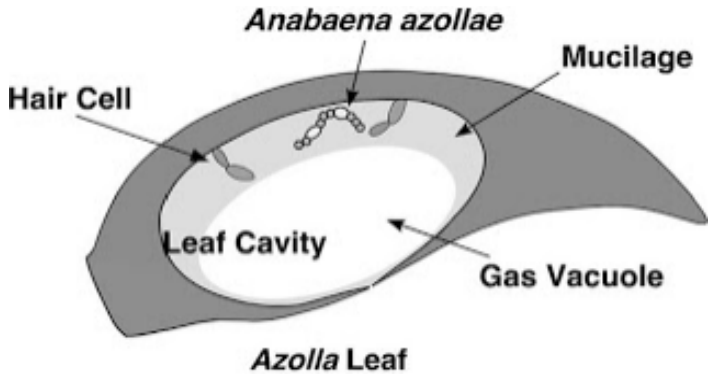
4. **What is *Azolla*?**

   *Azolla* is an aquatic fern belongs to the family Salviniaceae consisting of a short, branched, floating stem, bearing roots which hang down in the water which can rapidly colonize wetlands and produce large amounts of biomass.

5. **What is *Azolla* biofertilizer?**

   *Azolla* is a free floating pteridophyte, which contains nitrogen fixing blue green algae *Anabaena azollae. Azolla* can be applied directly into soil before transplanting of rice plant. *Azolla* can also be grow as a dual crop along with rice in the rice field.

6. **What do you mean by *Azolla* and *Anabaena azollae* association?**




Anabaena azollae is a free living blue green algae (living on its own in aquatic environment) that associates with aquatic fern Azolla as an endosymbiont. Symbiotic relationship between Azolla and Anabaena azollae has originated from co-evolution of leaf hairs and plasmalemmasomes.

**Leaf hairs:** The hairs on Azolla leaves have been proposed to be secretory or glandular and cavities filled with mucilaginous substances of unknown composition. The hairs in the leaf cavity increases the surface are of the cell membrane for transport.

**Plasmalemmasomes:** Plasmalemmasomes are infolding inside the cell wall. This is said to help exchanges of metabolites between the symbiont and the host.

7. **Explain nitrogen fixation process by blue green algae?**

Nitrogen fixation is a remarkable prokaryotic skill in which inert atmospheric nitrogen gas ($N_2$) is combined with hydrogen to form ammonia ($NH_3$). This vital process along with nitrification (formation of nitrites and nitrates) and ammonification (formation of ammonia from protein decay) make nitrogen available to autotrophic plants and ultimately to all members of the ecosystem. Although **Azolla** can absorb nitrates from the water, it can also absorb ammonia secreted by **Anabaena** within the leaf cavities.

$$N_2 + 8\ H^+ + 8e^- + 16\ ATP + 16\ H_2O = 2\ NH_3 + H_2 + 16\ ADP + 16\ Pi$$

Two molecules of ammonia are produced from one molecule of nitrogen gas. The reaction requires 16 molecules of ATP and a supply of electrons and protons (hydrogen ions) plus the enzyme nitrogenase. Nitrogenase consists of two proteins, an iron protein and a molybdenum-iron protein. The reaction occurs while N2 is bound to the nitogenase enzyme complex. The Fe protein is first reduced by electrons donated by ferredoxin. Then the reduced Fe protein binds ATP and reduces the molybdenum-iron protein, which donates electrons to N2, producing HN=NH. In two futher cycles of this process (each requiring electrons donated by ferredoxin) HN=NH is reduced to H2N-NH2, and this in turn is reduced to 2 NH3. Depending on the type of microorganism, the reduced ferredoxin supplies electrons for this process in generated by photosynthesis, respiration or fermentation.

8. **Write the growth factors for the growth of *Azolla*?**

**Water:** Maintenance of adequate water level (10-15 cm) is necessary for Azolla multiplication. It prefers to grow in a free floating state on the water surface.

**Temperature:** *Azolla* grows over a wide range of temperatures of 14-40°C but optimum temperature for enormous growth of *Azolla* is 25-30°C

**Humidity:** Moisture is the important requirement for the growth of *Azolla*. The optimum humidity requirement is 80-90%.

**Light:** *Azolla* requires light for photosynthesis and production of organic carbon compounds needed for cell synthesis. It prefers to grow under partial shade.

**Soil pH:** Maximum productions of biomass are possible in slightly acidic soil having 5.2 to 5.8. pH.

**Nutrition:** Nitrogen fixing fern Azolla does not require nitrogenous fertilizer for its growth. 4-20 kg $P_2 O_5$ /ha is desirable for biomass production.

**9. Write the role of *Azolla* in rice productivity?**

a. For growing rice crops, less than 5% of the nitrogen delivered by *Azolla* immediately. The remaining 95% nitrogen remains in the *Azolla*'s biomass will be utilized until the plants die, its organic nitrogen compounds will be mineralized and released as ammonia, which is available as bio-fertilizer for the rice plants. *Azolla* can rise crop yield by 30-40 percent.

b. It has been demonstrated that Azolla is good source of potassium when applied to paddy field and it also play an important role in maintenance of soil's fertility.

c. Decomposition of *Azolla* forms humus compound which increases the water holding capacity, aeration, drainage and aggregation essential for highly productive soil.

d. *Azolla* forms a thick, light proof mat which suppresses weed growth.

**10. Write the role of Blue Green Algae (BGA) in rice productivity?**

a. Blue Green Algae (BGA) plays important role in management of soil fertility, consequently increasing rice growth and yield as bio-fertilizer.

b. It supplies growth promoting substances such as hormones (Auxine and Gibbereline), vitamins and amino acids.

c. *Azolla* increases water holding capacity through their jelly structure and prevents growth of weeds.

d. The most important role of Azolla is in increasing of availability of soil nitrogen and phosphate.

Fig1: *Azolla sp.*

Fig2: *Anabaena azollae*

References: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