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Importance of Algae in Agriculture

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Introduction:

Algae are primarily aquatic organisms and, like terrestrial plants, possess the ability of photosynthesis by capturing the energy from sunlight and fixing carbon dioxide (CO_2) into biomass. Algae are supposed to be the ancestor of modern plants; therefore, the lineage of their photosynthetic machinery connects to cyanobacteria. Although algae and plants are different in many aspects, they share the most important fundamental process: photosynthesis. That makes algae distinguished and valuable. Algae are a large and diverse group of lower plants, including distantly related groups of micro-organisms that can perform photosynthesis, in which they capture energy from sunlight. Algae range from large complex marine forms called seaweed to minute unicellular Pico-plankton. Algae growth is often viewed as a problem, as it grows within backyard swimming pools and in-home fish tanks. On the other hand, algae play an important role in agriculture where they are used as bio fertilizer and soil stabilizers.

Algae as a Bio-fertilizer: Living microbes known as "Bio-fertilizers" are used to improve the chemical and biological properties of soil, restore soil fertility, and promote plant growth and development. Nitrogen deficiency can be corrected by using enough bio-fertilizers, which is essential for plant growth. On the other hand excessive use of chemical or synthetic fertilizers contaminate environment and may eventually leads to the ecosystem imbalance.

Bio fertilizers have emerged as best alternative to synthetic fertilizers. Emergence of organic farming is an important area of priority in respect of the growing demand for healthy food and long term sustainability. A bio fertilizer comprises living microorganisms, which on application colonizes the rhizosphere or the interior of the plant, plantlet or seed surfaces or soil, thus promoting growth by accelerating the availability of primary nutrients to the host plant. Biofertilizers comprise of microorganisms, including bacteria, fungi, cyanobacteria, and algae as well as their metabolites that are capable of enhancing soil, crop growth, and yield. Algal biofertilizers like the BGA such as Nostoc sp.,

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Anabaena sp., Tolypothrix sp., Aulosira sp. etc., have the potential to fix atmospheric nitrogen and are used in paddy fields. Beneficial effects of cyanobacterial inoculation have been reported on a number of other crops such as barley, oats, tomato, radish, cotton, sugarcane, maize, chilli, and lettuce (Thajuddinet al., 2005). Malliga et al., 1996 has reported that Anabaena azollae utilized as biofertilizer displayed lignolysis and released phenolic compounds, which induced profuse sporulation of the organism. Cyanobacteria play a spectrum of remarkable roles in the field of biofertilizer, energy production, human food, animal feed, polysaccharides, biochemical, pharmaceutical, and changing up of the environment. The cyanobacteria provide inexpensive nitrogen to plants besides increasing crop yield by making the soil fertile and productive. BGA biofertilizer in rice popularly known as “algalization” helps in creating an environment friendly agro-ecosystem that ensures economic viability in paddy cultivation while saving energy intensive inputs.

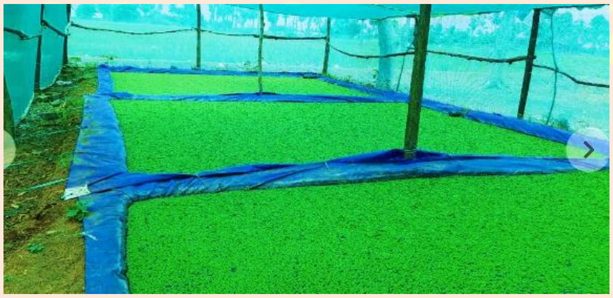

Fig. 1: Azola as a biofertilizer

Some other types include mycorrhizae, organic fertilizers, and phosphate-solubilizing bacteria. Pantoea agglomerans, one of the phosphate-solubilizing bacteria such as strain P5, and Pseudomonas putida strain P13 are capable of solubilizing the insoluble phosphate from organic and inorganic sources. The Azolla-Anabaena and Rhizobium form the most important group of biofertilizers. Biofertilizers have numerous benefits to soil quality and crop yield as they enhance nutrient transfer, increase population of beneficial microorganisms, stabilize soil aggregates, and decrease reliance on fossil fuels.

Algae as a Soil health booster: The contributions of algae include

- ✓ Enhancement in soil porosity by a group of cyanobacteria having filamentous structure and production of adhesive substances;
- ✓ Excretion of growth-promoting substances such as hormones (auxin, gibberellin), vitamins, and amino acids;
- ✓ Increase in water holding capacity through their jelly structure;
- ✓ Increase in soil biomass following their death and decomposition;
- ✓ Decrease in soil salinity;
- ✓ Prevention of weed growth; and
- ✓ Increase in soil phosphate by excretion of organic acids.

Uptake of P and N: Algae (Cyanobacteria) also have some soil phosphate-solubilizing species. Phosphorus (P) is the second important nutrient after nitrogen for plants and microorganisms. Most aquatic systems are resource-limited, where P and N are often the primary limiting nutrients. To ensure survival, a competitor must be able to maintain net population growth at resource levels less than those required by other species. Algae are particularly adapted to scavenge their environments for resources through structural changes, storage or increased resource utilization efficiency. Internal adjustments by algae involve biochemical and physiological adaptations, whilst they can also excrete substances to enhance nutrient availability. Algae excrete extracellular phosphatases almost immediately upon the onset of P limited conditions. Algae can also excrete other compounds and change the pH of their surroundings, which in turn can render adsorbed P available. In addition, algae can store resources like P in excess of their immediate needs.

Nitrogen fixation: Algae, especially cyanobacteria, may be the most important nitrogen-fixing agents in many agricultural soils. Their importance as nitrogen fixers in rice fields have been studied by several investigators. The nitrogen fixed by the algae is liberated and then re-assimilated by the higher plants. A large variety of cyanobacterial species are known to be nitrogen fixing and their importance in improving soil fertility for sustainable agriculture in submerged and irrigated rice cultivation is well recognized. The use of cyanobacteria as a biofertilizer for rice fields is very promising but limited due to fluctuation in quality and quantity of inoculum and its physiological attributes in varied agroecological regions. Utilization efficiency of fixed nitrogen by rice plants is often low and efforts are therefore being extended to isolate suitable strains of cyanobacteria that would be prolific not only in fixing atmospheric nitrogen but also in excreting it continuously, thus making it available to the growing rice plants.

Source of organic matter: Algae are also important source of organic matter in soil. The organic matter formed from the death and decay of algae may get mixed in the soil and mucilage acts as binding agent for soil texture, thereby increasing the humus content and making it more habitable for other plants after some years. Humus accumulation is also important for moisture retention. Filamentous forms of the Cyanophyceae, especially *Oscillatoria*, *Schizothrix* and *Plectonema* were found to be important in soil formation. In most cases, it is generally accepted that the incorporation of organic carbon via photosynthesis and of organic nitrogen via nitrogen fixation is the most important contributions of algae added to the soil. They also act as a reserve of inorganic nutrients.

Soil reclamation: The difficulties in soil reclamation in arid and semi-arid regions are mostly the salinity conditions of large soil areas. Several studies have been carried out on the effect of salinity on the growth, metabolism and yield of the plants and algae. Some growth regulators such gibberellic acid (GA3) were used for improving the salt tolerance of the plants. From an economic point of view, growth regulators are expensive and are non-practical especially, when applied in large amounts. Algae play an economic role in soil reclamation increases soil fertility and improve the plant conditions under certain environmental factors.

Reducing Agricultural Runoff: Algae particularly the seaweeds are used as fertilizers, resulting in less nitrogen and phosphorous runoff than results from the use of livestock manure. This, in turn, increases the quality of water flowing into rivers and oceans, according to a May 2010 article in "Agricultural Research."

Food Supplements: Algae are cultivated around the world and used as human food supplements. Algae can produce a clean and carbon-neutral food. Algae can be grown on abandoned lands and arid and desert lands with minimal demands for fresh water. A article published in 2011 in “Algae Industry Magazine” states that one thousand-acre chlorella farm could produce 10,000 tons of protein a year.

Fodder for Milk Cattle and Hens: Algae are also used for feeding livestock and hens. Seaweeds are an important source of iodine. Iodine levels in milk depend on what the cow producing the milk has been fed. Feeding milk cattle with seaweeds can increase the quantity of iodine in milk. Egg-laying rates in hens are also increased by algae feed additives.

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