

BIOFERTILIZERS IN AQUACULTURE

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Background: Why bio-fertilizers?

With the introduction of green revolution technologies the modern agriculture is getting more and more dependent upon the steady supply of synthetic inputs (mainly fertilizers) which are products of fossil fuel (coal+ petroleum). Excessive dependence of modern agriculture and the supply of these synthetic inputs and the adverse effects being noticed due to their excessive and imbalanced use has compelled the scientific fraternity to look for alternatives.

(i) Availability and cost of commercial fertilizers

Demand is much higher than the availability. It is estimated that by 2020, to achieve the targeted production of 321 million tonnes of food grain, the requirement of nutrient will be 28.8 million tonnes, while their availability will be only 21.6 million tonnes being a deficit of about 7.2 million tonnes. Increasing costs are getting unaffordable by small and marginal farmers

(ii) Effect of Chemical fertilizers in soil and environment

Excessive and imbalanced use of chemical fertilizers has adversely affected the soil causing decrease in organic carbon, reduction in microbial flora of soil, increasing acidity and alkalinity and hardening of soil. Moreover, excessive use of nitrogenous fertilizer are contaminating water bodies thus affecting fish fauna and causing health hazards for human beings and animals. Production of chemical fertilizers adds to the pollution. To overcome the deficit in nutrient supply and to overcome the adverse effects of chemical cultivation it is suggested that efforts should be made to exploit all the available resources of nutrients under the theme of integrated nutrient

management. Under this approach the best available option lies in the complimentary use of Biofertilizers, organic manures in suitable combination of chemical fertilizers.

What are Biofertilizers?

Biofertilizers are ready to use live formulates of such beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity in particular, and help build up the micro-flora and in turn the soil health in general. Although biofertilizers are now being used in agriculture fields, it can equivocally be stated that biofertilizers may also be used in fish culture practices. Field studies had shown that about 30 kg of Nitrogen can be saved per hectare by the use of cyanobacterial biofertilizers.

Benefits of biofertilizers

- ◆ Increase crop yield by 20-30%
- ◆ Replace chemical Nitrogen and Phosphatic fertilizers by 25 %
- ◆ Stimulate plant growth
- ◆ Activate soil biologically
- ◆ Restore natural fertility
- ◆ Increases soil organic matter and maintains a good soil texture
- ◆ Environmentally friendly - Don't pollute the environment
- ◆ Cheaper than fertilizers
- ◆ Believed to have growth promoting substances
- ◆ Provide protection against drought and some soil borne diseases

Types of Biofertilizers

Most biofertilizers belong to one of these two categories:

- (a). Nitrogen fixing
- (a). Phosphate solubilising.

For Nitrogen:

- ◆ Rhizobium for legume crops
- ◆ Azotobacter/Azospirillum for non-legume crops
- ◆ Acetobacter for sugarcane only
- ◆ BGA and Azolla for low land paddy and aquaculture

For Phosphorous

Phosphatika for all crops to be applied with Rhizobium, Azotobacter, Azospirillum and Acetobacter

For enriched compost

Cellulolytic fungal culture

Phosphotika and Azotobacter culture

Method of Application

Seed treatment:

Suspend 200 gm Nitrogenous biofertilizer and 200 gms Phosphotika in 300-400 ml of water and mix thoroughly. Mix this paste with 10 kg seeds & dry in shade. Sow immediately.

Seedling root dip:

For vegetables, 1 kg each of two biofertilizers is to be mixed in sufficient quantity of water. Dip the roots of seedlings in this suspension for 30-40 min before transplanting. For paddy make a bed in the field and fill it with water. Mix biofertilizers in water and dip the roots of seedlings for 8-10 hrs.

Soil treatment:

Mix 4 kg each of biofertilizers in 200 kg of compost and leave it overnight. Apply this mixture in the soil at the time of sowing or planting. In plantation crops apply this mixture near root zone and cover with soil.

Nitrogen fixing biofertilizers

Free-living or symbiotic bacteria and blue-green algae (Cyanobacteria) fix atmospheric gaseous nitrogen as ammonia and release it, increasing the fertility of soil and water. These include Rhizobium, Azotobacter, Acetobacter, Azospirillum, Blue Green Algae (BGA) and Azolla. While Rhizobium, Azolla requires symbiotic association to fix nitrogen, others can fix nitrogen independently. Anabaena azollae living in leaf cavities of Azolla (aquatic fern) are very efficient nitrogen fixers, and contribute about 500 kg N/ha/year.

Phosphate solubilising biofertilizers

Phosphate solubilising micro-organisms (PSM) secrete organic acids which enhance the uptake of phosphorus by plants by dissolving rock phosphate and tricalcium phosphates. PSMs (e.g. Phosphatika) are particularly valuable as they are not crop specific and can benefit all crops.

Composting bio-fertilizers

Compositing biofertilizers are used for hastening the process of composting and for enriching its nutrient value. Composting process is enhanced by enzymes secreted by microorganisms (Cellulolytic fungal culture) to hydrolyse pectins, xylans, hemicellulose and cellulose releasing beneficial micronutrients for the plants.

Biofertilizers generally used in Aquaculture

1. Azolla
2. Phosphatase bacteria and phosphate solubilizing bacteria
3. Nitrogen fixing bacteria
4. Nitrogen fixing cyanobacteria
5. Enriched compost

1. Azolla

Azolla is a dichotomously branched (dichotomy is a mode of branching by repeated

bifurcation) free floating aquatic fern is naturally available mostly on moist soils, ditches marshy ponds and is widely distributed in tropical belt of India. The shape of Indian species is typically triangular measuring about 1.5 to 3.0 cm in length 1 to 2 cm in breadth.

Roots emanating from growing branches remained suspended in water. The dorsal lobe which remains exposed to air is having a specific cavity containing its symbiotic partner, a Blue Green Algae (BGA), the *Anabaena Azolae*. The fern is capable of fixing atmospheric nitrogen in the soil in the form of NH_4^+ and becomes available as soluble nitrogen for the wet land rice crop, which is the major cereal for the people of the North East. Owing to the poor economic conditions of the farmers of the North Eastern States, rice crop is mostly grown under natural soil fertility with minimum inputs and amelioratives. But for taking a good crop of rice, judicious application of nutrients is necessary. Besides, this, the farmers of the state of Meghalaya and other north eastern states have apathy in using chemical fertilizers in crop production. For sustainable crop production, there is a practice to supply some quantity of nutrients through organic manure, viz; FYM and composted plant residues and biofertilizers.

In the context of depletion of soil fertility and high prices of chemical fertilizer, it has become imperative to use biofertilizer which is a cheaper and renewable source of low cost plant nutrient and playing a major role in Integrated Plant Nutrient Supply System. Use of *Azolla* fern as a bio-fertilizer is advocated to minimize the dependency of chemical fertilizer. *Azolla* supplements nitrogen to rice crop by fixing atmospheric nitrogen in the soil for crop growth, crop production and maintain soil fertility.

Economic Value

On dry weight basis *Azolla* contains the following chemical compositions:

Nitrogen : 5.0 %

Phosphorous	:	0.5 %
Potassium	:	2.0-4.5 %
Calcium	:	0.1-1.0 %
Magnesium	:	0.65 %
Manganese	:	0.16 %
Iron	:	0.26 %
Crude Fat	:	3.0-3.3 %
Sugar	:	3.4-3.5 %
Starch	:	6.5 %
Chlorophyll	:	0.34-0.55 %
Ash	:	10.0 %

Adaptability

Azolla Caroliniana, is identified as a cold tolerant species and survives well even at very low winter temperature of 5°C during the months of December to February in mid hills of Meghalaya. *Azolla pinnata*, is a local isolate found widely in the entire North Eastern Region, but does not survive under mid hills of Meghalaya. However, *Azolla caroliniana*, has shown its adaptability in hills and other similar locations. *Azolla caroliniana*, can be preserved in shallow pond having 15 cm of standing water and by providing shade 10-15 cm above the pond water surface through weeds or paddy straw. For raising *Azolla* inoculum a pond size of 3 m x 2 m x 1 m is most desirable. Under such weed or straw mulch cover, the *Azolla* multiplies rapidly and inoculum will be ready within a period of 20-25 days for further releasing in the main multiplication ponds on the onset of monsoon in the month of April.

How to grow Azolla?

Azolla can easily be cultivated separately for periodic application in fish ponds. The system of cultivation involves a network of earthen raceways (20X3.0X0.6m) with water supply and drainage facilities. In each raceways, 6 kg of *Azolla* is incorporated. 65grams of single super phosphate is added. Water depth of 10-15 cm to