e ISSN–2321–7987 | ●●● Article ●●● |Visit us : *www.researchjournal.co.in*|

Biofertilizers application in agriculture

Mahendra Singh[1] **and Santosh Kumar[2]**

[1]Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour, BHAGALPUR (BIHAR) INDIA

[2]Department of Plant Pathology, Bihar Agricultural University, Sabour, BHAGALPUR (BIHAR) INDIA

Biofertilizers are the preparations containing cells of micro-organisms which may be nitrogen fixers, phosphorus solubilizer. Sulphur oxidizers or organic matter decomposers. In short, when applied to 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 are not fertilizers. Fertilizers directly increase soil fertility by adding nutrients. Bio-fertilizers add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus and stimulating plant growth through the synthesis of growth promoting substances. They can be grouped in different ways based on their nature and function.

Different types of bio-fertilizers

Different types of bio-fertilizers:

Rhizobium : This belongs to bacterial group and the classical example is symbiotic nitrogen fixation. The bacteria infect the legume root and form root nodules within which they reduce molecular nitrogen to ammonia which is reality utilized by the plant to produce valuable proteins, vitamins and other nitrogen containing compounds. The site of symbiosis is within the root nodules. It has been estimated that 40-250 kg N / ha / year is fixed by different legume crops by the microbial activities of *Rhizobium*. Table shows the N fixation rates.

Azotobacter : It is the important and well known free living nitrogen fixing aerobic bacterium. It is used as a bio-fertilizer for all non-leguminous plants especially rice, cotton, vegetables etc. *Azotobacter* cells are not present on the rhizosplane but are abundant in the rhizosphere region. The lack of organic matter in the soil is a limiting factor for the proliferation of *Azotobaceter* in the soil.

Azospirillum : It belongs to bacteria and is known to fix the considerable quantity of nitrogen in the range of 20-40 kg N/ha in the rhizosphere in non- non-leguminous plants such as cereals, millets, oilseeds, cotton etc.

Cyanobacteria : A group of one-celled to many-celled aquatic organisms. Also known as blue-green algae.

Azolla : *Azolla* is a free-floating water fern that floats in water and fixes atmospheric nitrogen in association with nitrogen fixing blue green alga Anabaenaazollae. *Azolla* fronds consist of sporophyte with a floating rhizome and small overlapping bi-lobed leaves and roots. *Azolla* is considered to be a potential bio-fertilizer in terms of nitrogen contribution to rice. Long before its cultivation as a green manure,*Azolla* has been used as a fodder for domesticated animals such as pigs and ducks. In recent days, *Azolla* is very much used as a sustainable feed substitute for livestock especially dairy cattle, poultry, piggery and fish.

Phosphate solubilizing micro-organisms (*PSM*):

AM fungi : An arbuscular mycorrhiza (AM Fungi) is a type of mycorrhiza in which the fungus penetrates the cortical cells of the roots of a vascular plant.

Silicate solubilizing bacteria (*SSB*): Micro-organisms are capable of degrading silicates and aluminum silicates. During the metabolism of microbes several organic acids are produced and these have a dual role in silicate weathering.

Plant growth promoting rhizobacteria (*PGPR*):The group of bacteria that colonize roots or rhizosphere soil and beneficial to crops are referred to as plant growth promoting rhizobacteria (PGPR).

Liquid bio-fertilizers :

Benefits:

The advantages of liquid bio-fertilizer over conventional carrier based bio-fertilizers are listed below:

– Longer shelf-life -12-24 months.
– No contamination.
– No loss of properties due to storage up to 45°C.
– Greater potentials to fight with native population.
– Easy identification by typical fermented smell.
– Better survival on seeds and soil.
– Very much easy to use by the farmer.
– High commercial revenues.

– High export potential.

Characteristics of different liquid bio-fertilizers:

Rhizobium:

Physical features of liquid *Rhizobium* :

– Dull white in colour
– No bad smell
– No foam formation, pH 6.8-7.5

Azospirllium :

Physical features of liquid*Azospirillum* :

– The colour of the liquid may be blue or dull white.
– Bad odours confirms improper liquid formulation and may be concluded as mere broth.
– Production of yellow gummy colour materials confirms the quality product.
– Acidic pH always confirms that there is no *Azospirillum* bacteria in the liquid.

Role of liquid *Azospirillum* under field conditions:

– Stimulates growth and imparts green colour which is a characteristic of a healthy plant.
– Aids utilization of potash, phosphorus and other nutrients.
– Encourage plumpness and succulence of fruits and increase protein percentage.

Azotobacter:

Physical features of liquid *Azotobacter* :

The pigmentation that is produced by *Azotobacter* in aged culture is melanin which is due to oxidation of tyrosine by tyrosinase an enzyme which has copper. The colour can be noted in liquid forms. Some of the pigmentation are described below :

– *A. chroococcum*: Produces brown-black pigmentation in liquid inoculum.

Table 1: Specification of fertilizers grouped in different ways based on their nature and function

Sr. No.	Groups	Examples
N_2 fixing biofertilizers		
1.	Free-living	*Azotobacter, Clostridium, Anabaena, Nostoc,*
2.	Symbiotic	*Rhizobium, Frankia, Anabaena azollae*
3.	Associative symbiotic	*Azospirillum*
P Solubilizing biofertilizers		
1.	Bacteria	*Bacillus megaterium* var. phosphaticum *Bacillus circulans, Pseudomonas striata*
2.	Fungi	*Penicillium* sp, *Aspergillus awamori*
P Mobilizing biofertilizers		
1.	Arbuscular mycorrhiza	*Glomus* sp.,*Gigaspora* sp.,*Acaulospora* sp., *Scutellospora* sp. and *Sclerocystis* sp.
2.	Ectomycorrhiza	*Laccaria* sp.,*Pisolithus* sp., *Boletus* sp., *Amanita* sp.
3.	Orchid mycorrhiza	*Rhizoctonia solani*
Biofertilizers for micro nutrients		
1.	Silicate and zinc solubilizers	*Bacillus* sp.
Plant growth promoting Rhizobacteria		
1.	Pseudomonas	*Pseudomonas fluorescens*

Table 2 : Quantity of biological N fixed by liqiud *Rhizobium* in different crops

Host group	*Rhizobium* species	Crops	N fix kg/ha
Pea group	*Rhizobium leguminosarum*	Green pea, lentil	62- 132
Soybean group	*R. japonicum*	Soybean	57- 105
Lupini group	*R. lupine orinthopus*	Lupinus	70- 90
Alfafa.group	*R. melliloti, R. Medicago* and *R.Trigonella*	Melilotus	100- 150
Beans group	*R. phaseoli*	Phaseoli	80- 110
Clover group	*R. trifoli*	Trifolium	130
Cowpea group	*R. species*	Moong, redgram, cowpea, groundnut	57- 105
Cicer group	*R. species*	Bengal gram	75- 117

– *A. beijerinchii*: Produces yellow- light brown pigmentation in liquid inoculum
– *A. vinelandii*: Produces green fluorescent pigmentation in liquid inoculum.
– *A. paspali* Produces green fluorescent pigmentation in liquid inoculum.
– *A. macrocytogenes*: Produces, pink pigmentation in liquid inoculum.
– *A. insignis*: Produces less, gum less, grayish-blue pigmentation in liquid inoculum.
– *A. agilies*: Produces green-fluorescent pigmentation in liquid inoculum.

Acetobaceter :

This is a sacharophillic bacteria and associate with sugarcane, sweet potato and sweet sorghum plants and fixes 30 kgs/ N/ ha year. Mainly this bacterium is commercialized for sugarcane crop. It is known to increase yield by 10-20 t/ acre and sugar content by about 10-15 per cent.

Liquid bio-fertilizer application methodology :

There are three ways of using liquid bio-fertilizers.
– Seed treatment
– Root dipping
– Soil application

Dosage of liquid bio-fertilizers in different crops: Recommended liquid bio-fertilizers and its application method, quantity to be used for different crops are as follows:

Application of bio-fertilizers :
– Seed treatment or seed inoculation
– Seedling root dip
– Main field application

Seed treatment: One packet of the inoculants is mixed with 200 ml of rice kanji to make a slurry. The seeds required for an acre are mixed in the slurry so as to have a uniform coating of the inoculant over the seeds and then shade dried for 30 minutes. The shade dried seeds should be sown within 24 hours. One packet of the inoculant (200 g) is sufficient to treat 10 kg of seeds.

Seedling root dip : This method is used for transplanted crops. Two packets of the inoculant is mixed in 40 litres of water. The root portion of the seedlings required for an acre is dipped in the mixture for 5 to 10 minutes and then transplanted.

Main field application : Four packets of the inoculant is mixed with 20 kgs of dried and powdered farm yard manure and then broadcasted in one acre of main field

Table 3 : Dosage of liquid bio-fertilizers in different crops

Crop	Recommended biofertilizer	Application method	Quantity to be used
Field crops			
Pulses			
Chickpea, pea, groundnut, soybean, beans, lentil, lucern, berseem, green gram, black gram, cowpea and pigeonpea	*Rhizobium*	Seed treatment	200 ml/ acre
Cereals	*Azotobacter/ Azospirillum*	Seed treatment	200 ml/ acre
Wheat, oat, barley			
Rice	*Azospirillum*	Seed treatment	200 ml/ acre
Oil seeds	*Azotobacter*	Seed treatment	200 ml/ acre
Mustard, seasumum, linseeds, sunflower, castor			
Millets	*Azotobacter*	Seed treatment	200 ml/ acre
Pearl millets, finger millets, kodo millet			
Maize and sorghum	*Azospirillum*	Seed treatment	200 ml/ acre
Forage crops and grasses	*Azotobacter*	Seed treatment	200 ml/ acre
Bermuda grass, sudan grass, napier grass , paragrass, stargrass etc.	*Azotobacter*	Seedling treatment	500 ml/ acre
Other misc. plantation crops			
Tobacco	*Azotobacter*	Soil treatment	400 ml/ acre
Tea, coffee			
Rubber, coconuts	*Azotobacter*	Soil treatment	2-3 ml/ plant
Agro-forestRY/fruit plants	*Azotobacter*	Soil treatment	2-3 ml/plant at nursery
All fruit/agro-forestry (herb, shrubs, annuals and perennial) plants for fuel wood fodder, fruits, gums, spices, leaves, flowers, nuts and seeds purpose			
Leguminous plants/ trees	*Rhizobium*	Soil treatment	1-2 ml/ plant

Table 4 : *Rhizobium* (only seed application is recommended)

Sr. No.	Crop	Total requirement of packets per ha
1.	Soybean	5
2.	Groundnut	5
3.	Bengalgram	5
4.	Blackgram	3
5.	Greengram	3
6.	Redgram	3
7.	Cowpea	3

just before transplanting.

Rhizobium: For all legumes, *Rhizobium* is applied as seed inoculant.

Azospirillum/Azotobacter: In the transplanted crops, *Azospirillum* is inoculated through seed, seedling root dip and soil application methods. For direct sown crops, *Azospirillum* is applied through seed treatment and soil application.

Precautions :

–Bacterial inoculants should not be mixed with insecticide, fungicide, herbicide and fertilizers.

–Seed treatment with bacterial inoculant is to be done at last when seeds are treated with fungicides.

Constraints in bio-fertilizer technology: Though the bio-fertilizer technology is a low cost, ecofriendly technology, several constraints limit the application or implementation of the technology the constraints may be environmental, technological, infrastructural, financial, human resources, unawareness, quality, marketing, etc. The different constraints in one way or other affecting the technique at production, or marketing or usage.

Technological constraints:

–Use of improper, less efficient strains for production.

–Lack of qualified technical personnel in production units.

–Production of poor quality inoculants without understanding the basic microbiological techniques

–Short shelf-life of inoculants.

Infrastructural constraints:

–Non-availability of suitable facilities for production

–Lack of essential equipments, power supply, etc.

–Space availability for laboratory, production, storage, etc.

– Lack of facility for cold storage of inoculant packets

Financial constraints :

– Non-availability of sufficient funds and problems in getting bank loans

– Less return by sale of products in smaller production units.

Environmental constraints:

– Seasonal demand for bio-fertilizers

– Simultaneous cropping operations and short span of sowing/planting in a particular locality

– Soil characteristics like salinity, acidity, drought, water logging, etc.

Human resources and quality constraints:

– Lack of technically qualified staff in the production units.

– Lack of suitable training on the production techniques.

– Ignorance on the quality of the product by the manufacturer

– Non-availability of quality specifications and quick quality control methods

– No regulation or act on the quality of the products

– Awareness on the technology

– Unawareness on the benefits of the technology

– Problem in the adoption of the technology by the farmers due to different methods of inoculation.

– No visual difference in the crop growth immediately as that of inorganic fertilizer

Received : *26.07.2014* ***Revised :*** *03.04.2015* ***Accepted :*** *18.04.2015*