Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 02, Issue: 04 (JULY-AUGUST, 2022)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Liquid Biofertilizers

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Abstract
Liquid biofertilizers (LFs) contain specific beneficial microorganisms capable of fixing, solubilizing and mobilizing plant nutrients through their biological activity. For direct application in the soil, organic fertilizers are first mixed with carriers such as soil, farmyard manure, compost, rice husks or lignite and then applied directly to the soil. Biofertilizers such as Rhizobium and phosphate-soluble bacteria play an important role in increasing the availability of phosphorus and nitrogen by increasing biological N fixation and improving phosphorus availability to the plants. The use of organic liquid fertilizer significantly increased the yield and quality of the legumes. Liquid bio fertilizer formulation is one of the most promising and modern technologies. Despite many advantages over the agrochemicals, there has been significant contention among the farming community on several grounds regarding the viability of the organisms. Today LFs are available in the market as one of the alternatives to chemical pesticides and fertilizers. The LFs are applied by spraying or fertigation methods.

Key words: Liquid biofertilizers, classification, Application methodology of liquid bio-fertilizers, Precautions, Need of LFs, Benefits of liquid biofertilizers.

Introduction
India is an agricultural country, where 60-70% of the population is dependent on agriculture. As everyone knows, agriculture is the index of economic growth of any country. Therefore, good and healthy agriculture is necessary for every country. There are many hurdles to good farming practices, but one that has a greater impact on farming is the consequent reduction in land ownership. The liquid organic fertilizers are suspensions with useful microorganisms that fix atmospheric nitrogen and solubilize insoluble phosphates and make them available to the plants. Liquid bio-fertilizers are the microbial formulation containing beneficial microorganisms which are capable for fixing, mobilizing and dissolving the important plant nutrients from their biological activity. Liquid bio fertilizers can help improve the soil quality, maintain soil health and promote plant growth. Efficient soil microbes interact with plant roots, where they feed on root exudates and degrading the organic matter. Although beneficial microbes have the ability to deal with various environmental problems, their well-organized application to solve environmental problems has yet to be realized. They are eco-friendly, low-cost consortium of microbes equipped with an appropriate liquid medium to maintain their viability for a period of time, help to improve the biological activity of the target areas. They have cell protectants or chemicals that enhanced dormant spores and cysts for longer shelf-life and tolerant to adverse conditions. LFs are useful microorganisms related to agriculture that fix atmospheric nitrogen and insoluble phosphorus to provide soluble forms for the plants. Using this organic fertilizer is environmentally, friendly and mostly produces a result similar to harvesting. The use of chemical fertilizer directly reduces 15 to

40%. It can be stored for a long time without special precautions and compared to solid - based organic fertilizer, its shelf life is in the range of one to two years. The demand for organic food is increasing in the global market.

Basically, LFs are the microbial preparations that contain specific beneficial microorganisms and are capable of fixing or solubilizing or mobilizing plant nutrients through their biological activity (Tamilkodiand Victoria, 2018). LFs are suspensions with agriculturally useful microorganisms that fix atmospheric nitrogen and solubilize insoluble phosphates and make them available to plants (Verma et al., 2018). LFs are the microbial formulation containing beneficial microorganisms capable of fixing, mobilizing or dissolving the important plant nutrients through their biological activity (Chopra and Mali, 2020). It has been recommended that, LFs, which are generally produced by fermentation of effective microorganisms, be used within three months (Nagampimol and Kunathigan, 2008). Today, ready-to-use LF from effective microorganisms is available on the market (Maheswari and Kalaiyarasi, 2015).

Need for Use of Liquid Bio-fertilizers

Sustainable agriculture is the artful production of safe, high-quality agricultural products, thereby protecting and improving the social and economic conditions of the natural environment, farmers, their workers and local communities, and protecting the health and welfare of all agricultural species. For a sustainable cultivation system, it is necessary to use renewable inputs (fertilizers, pesticides, water, etc.) that benefit the crop and do not harm the environment. There is a way to reduce the use of chemical fertilizers and pesticides. Liquid organic fertilizer is the best type of carrier-based fertilizer because LBF does not easily tolerate radiation and contamination and extends their lifespan by 10-12 months. It is free from moisture requirements and can be easily used by farmers.

Classification of Liquid Biofertilizers

1.Nitrogen fixers: Microbes that fix nitrogen symbiotically and non-symbiotically. Ex - *Rhizobium, Azotobacter, Azospirillum*. Two types of nitrogen-fixing microorganisms are recognized: free-living (non-symbiotic) bacteria, including the cyanobacteria (or blue-green algae) *Anabaena* and *Nostoc*, and genera such as *Azotobacter, Beijerinckia*, and *Clostridium*; and mutual (symbiotic) bacteria such as Rhizobium associated with legumes and various Azospirillum species associated with cereal grasses.

2.Phosphorus solubilizers and mobilizers: Microbes that solubilize or mobilize important plant nutrients such as P, Cu, Zn, Mo etc. Examples of some important solubilizers or mobilizers are *Pseudomonas striata*, *Bacillus polymyxa*, *Aspergillus niger*, *Penicillium digitatum, Glomus, Gigaspora and AM.*

3.Potash mobilizers: Microbes that mobilize elemental or potassium mixtures in the soil. The use of potash-mobilizing bacteria (KMB) would not only reduce the high cost of manufacturing potassium fertilizers, but would also mobilize insoluble potassium in soils and fertilizers to which they are applied. Ex. *Frateuria aurantia*.

Basic concept of liquid Biofertilizers

The basic concept of liquid biofertilizers is

1. Stabilization- The microbes stabilized during the production, distribution and storage.
2. Application- The prepared formulation should simply be delivered to the field in the effective manner.
3. Persistence- High persistence to protect the microbes in the field from harmful environmental influences.
4. Activity- Increase the activity, reproduction, interaction and contact with target crops, to enhance, increase the microbial activity at the field.

Preparation of liquid bio-fertilizers

Prepare 50 ml broth of all three microorganisms Rhizobium, Azatobactor, Bacillus as organic liquid fertilizer and inoculate isolated colonies on respective broth and incubate at 37 °C for 6-7 days. A similar procedure is followed to make 150 ml broth and mix the two broths and bring the volume to 200 ml. This mixture is ready to use for liquid organic fertilizer. Then in the next step the broth for each microorganism is prepared, the respective microorganism is inoculated and incubated at 37°C for 6-7 days, after that all three broths are mixed and shaken vigorously, this mixture is again incubated for 2 days. Now this broth is ready to use for liquid organic fertilizer. After the preparation of the liquid organic fertilizer, seeds are cultivated in pots and the liquid organic fertilizer is irrigated, showing the growth efficiency of the plants.

Application methodology of liquid bio-fertilizers

There are 4 ways of using liquid biofertilizers in fields and they are seed treatment, root dipping, soil application and with irrigation water.

1.Seed treatment: For all types of inoculants, seed treatment is the most common and effective strategy. 5-6ml of LF should be mixed with an equal amount of 10% starch solution or 10% jaggery solution per kg of seed in a plastic bag and the mixture should be evenly applied to the seed. Squeeze the bag for at least 2 minutes or until all seeds are evenly moistened. The bag is then opened, inflated and gently shaken in the shade for 20-30 minutes after opening the bag to dry. Another option is to coat large amounts of seed in a bucket and mix the inoculant by hand. Seed treatment with Rhizobium, Azotobacter, Azospirillum and PSM can be carried out, and treatment with any two or more than two bacteria can be carried out without side effects. The most important is that the seeds must be coated with Rhizobium, Azotobacter, Azospirillum and PSM vaccine as the outer layer.

2. Root dipping: This approach is used to apply the liquid organic fertilizer Azospirillum/PSM to rice and vegetable crops. 250-300 ml of LF inoculant must be combined with 5-10 liters of water in one area of the field and seedling roots must be soaked for at least half an hour before transplantation (Trimurtula and Rao, 2014).

3. Soil application: For one acre of main field, 250-300 ml liquid inoculum of each organism can be used. All inoculants should be diluted in 10-15 liters of water before mixing with 200kg of manure powder, vermicompost or other compost and incubating overnight before use. This mixture should be administered at the time of sowing or transplantation, particularly in the furrows under the seed surface and shortly after administration of microbial inoculants in tropical soils (Trimurtuluand Rao, 2014). In an experiment conducted by Maheshwari and Elakkiya (2014), the combined inoculation of LF Azospirillum + Rhizobium + Azotobacter showed better response in all parameters like leaf number, height, shoot length, root length and biochemical components like chlorophyll, carbohydrate protein and carotenoid content.

4. Foliar spray and fertigation: Liquid biofertilizers can be applied by spraying or by fertigation (Bhawsar, 2011). Because LF are generally concentrated, they must be diluted with water prior to application to the field to avoid burning the fertilizer. The organic fertilizer is mixed with water and other micronutrients in a tank during the fertigation. Irrigation sprinklers/sprayers/piping deliver it to specific plants. fertigation is commonly used in greenhouses or shade netting. Farmers can use liquid inoculants with drip irrigation systems on their main field by placing 250–300 mL of each organism per acre in a drip tank and releasing it within 10–15 days after transplantation/seeding (Trimurtuluand Rao, 2014).

Benefits of Liquid Biofertilizers

1. Easy to use.
2. Shelf life 12-24 months.
3. Cost effective.

4. Resistant to high temperature.
5. Contamination is nil.
6. Storage quality is good.
7. Require minimum dose for application.
8. Better survival on seeds and soil.
9. Very high enzymatic activity.

Precaution in the use of liquid biofertilizers

1. Organic fertilizers never mix with a chemical fertilizer.
2. Stored at room temperature not below 0°C and above 35°C. Store LF bottle in a cool and dry place.
3. Not exposed to direct sunlight.
4. Biofertilizers are being never applied with the fungicides, plant ash at a same time.
5. After the expiry period use of biofertilizer is hazardous.
6. Keep agrochemicals away from biofertilizers bottle.

Conclusion

These are eco-friendly, low-cost consortium of microbes equipped with an appropriate liquid medium to maintain their viability for a period of time and help improve the biological activity of the target areas. They have cell protectants or chemicals that encourage dormant spores and cysts for longer shelf life and tolerance to adverse conditions. Liquid organic fertilizers are recognized as the best choice for traditional carrier-based organic fertilizers in modern agriculture, helping to achieve higher crop yields, soil health and sustainable global food production. Liquid organic fertilizers are innovative agronomic inputs for sustainable agriculture. The quality standards of liquid organic fertilizers are good and stable for six months. With carrier-based organic fertilizers, the quality is very low, the amount of moisture is very high, and the bacterial count has decreased.

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