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Liquid Biofertilizer - A Boon to Sustainable Agriculture

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Abstract

The global necessity to increase agricultural production from a steadily decreasing and degrading land resource base has placed considerable strain on the fragile agro-ecosystems. In order to promote organic farming of the agriculturally important and high value crops in an eco-friendly and sustainable manner, biofertilizers/ microbial inoculants are important in restricting the soil degradation and environmental pollution and ameliorating the problem of low productivity. They are renewable, pollution free, eco-friendly and are of low cost. Liquid bioinoculants are special liquid formulations containing not only the desired microorganisms and their nutrients, but also, special cell protectants or substances that encourage the longer shelf life and tolerance to adverse conditions. Liquid inoculant formulation with good field performance characteristics that uses low cost materials and are easily attainable by small producers could overcome many problems associated with processing solid carriers.

Introduction

Sustainable farming systems strive to minimize the use of costly and environmental unfriendly synthetic pesticides/ agrochemicals, and to optimize the use of alternative management strategies to improve soil fertility and to control soil-borne pathogens. A more sustainable agriculture *i.e.* 'ecologically sound, economically viable, socially just and humane' should aim to recycle minerals in the soil with no or few external inputs, maintain a high biodiversity in agro-ecosystem and have better exploitation of soil-plant-microbe interactions for plant nutrition and protection. An answer to this is the biofertilizer, an environmental friendly fertilizer now used in many countries. During the last couple of decades, the use of Biofertilizers - PGPR for sustainable agriculture has increased tremendously in various parts of the world.

India is one of the important countries in biofertilizers production and consumption. In order to encourage the organic agriculture by biofertilizers, five biofertilizers namely *Rhizobium*, *Azotobacter*, *Azospirillum*, Phosphate solubilizing bacteria and mycorrhiza have been incorporated in the FCO, 1985. The average consumption in the country is about 45,000 tons per annum while the production being less than the half. At present in India there is a gap of about 10 million tones of plant nutrients between removal by crops and replenishment through fertilizers. It is evident that there is a tremendous gap between the annual demand and production of the biofertilizers globally especially in India. Hence, the judicious combination of chemical fertilizers and biofertilizers is also encouraged considering economical and ecological concerns. It is estimated that the present level of biofertilizers use is quite low and there is a substantial potential to increase it to

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50,000 to 60,000 tons by 2020.

Crises of agricultural land day by day, vertical increase in the cost of agriculture input technologies are leading to transitions in farming community. In such an agro critical scenario, a multi-faced solution for different constraints in agro industry is necessary. It is evident that Biofertilizer technology has inaugurated a new era in biological input technology and recorded a tremendous raise in the annual agriculture production particularly in the past two decades. To combat the threat of global food crises the alternative technologies in the agriculture like liquid biofertilizers are obligatory.

Biofertilizer

Biofertilizer is a substance containing living microorganisms, which, when applied to seeds, plant surfaces, or soil, colonies the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plants. Biofertilizers usually need a carrier as medium for the microbial inoculants (Chun-Li et al., 2014). A suitable carrier material needs to be inexpensive, easily available, and high in organic matter content, and should have a high water-holding capacity. Furthermore, a good quality carrier should be free from microbial contamination, and can optimize the growth of the biofertilizer microorganisms. However, it is not easy to get a carrier that meets the desired qualities. Liquid biofertilizer is the solution to the problems where no solid carrier is needed.

Figure 1: Liquid Biofertilizer and its application

Liquid Biofertilizer

Liquid biofertilizer of course have the capacity to replace the traditional chemical fertilizers & carrier based biofertilizers and plays a major role in restoring the soil health, but a lot of measures in terms of technology, government support, subsidies, and constructive awareness by well trained technicians among the agrarians are emphasized.

In agricultural eco-system, microorganisms have vital role in fixing/ solubilizing/ mobilizing/ nutrient recycling. These microorganisms occur in soils naturally, but their populations are often scanty. In order to increase the crop yield, the desired microbes from rhizosphere are isolated and artificially cultured in adequate count and mixed with suitable carriers or as they are in suitable combinations (Microbial consortium) by artificial culturing. These are known as biofertilizers or microbial inoculants.

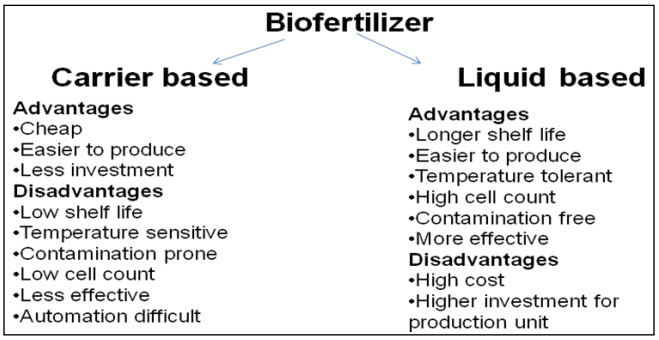

Figure 2: Formulation of Biofertilizers based on the carrier

Benefits of Liquid Biofertilizers

- Contains special cell protectants or substances that encourage formation of resting spores or cysts.
- Contains special nutrients that ensure longer shelf life.
- Better survival on seeds and soil and tolerance to adverse conditions. Liquid formation ensures that the product is easy to handle and apply.
- Since the organisms are stabilized during production, distribution and storage, the activity is enhanced after the contact and interaction with the target crops.
- No loss of properties due to storage up to 55 degrees.
- Greater potentials to fight with native population.
- Dosages are 10 times lesser than the carrier-based bio-fertilizers.
- Very high enzymatic activity since contamination is nil.

Characteristics of Different Liquid Biofertilizers

1. 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*.

2. Azospirllium

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-leguminous plants such as cereals, millets, Oilseeds, cotton etc. The efficiency of *Azospirillium* as a Biofertilizer has increased because of its ability of inducing abundant roots in several plants like rice, millets and oilseeds even in upland conditions. Considerable quantity of nitrogen fertilizer up to 25-30 % can be saved by the use of *Azospirillum* inoculant. The genus *Azospirillum* has three species viz., *A. lipoferum*, *A. brasilense* and *A. amazonense*. These species have been commercially exploited for the use as nitrogen supplying Biofertilizers.

3. 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 *Azotobacter* in the soil. Azotobacter have been found to produce some antifungal substance which inhibits the growth of some soil fungi like *Aspergillus, Fusarium, Curvularia, Alternaria, Helminthosporium, Fusarium* etc.

4. Phosphorus Solubilizing Microorganisms

Phosphorus solubilizing bacteria and fungi play a vital role in persuading the insoluble phosphatic compound such as rock phosphate, bone meal and basic slag and particularly the chemically fixed soil phosphorus into available form. These special types of microorganisms are known as Phosphate Solubilizing Microorganisms (PSM) which includes different groups of microorganisms such as bacteria and fungi that convert insoluble phosphatic compounds and fixed chemical fertilizers into soluble form. The species of *Pseudomonas*, *Micrococcus*, *Bacillus, Flavobacterium, Penicillium, Fusarium, Sclerotium, Aspergillus* and some other are considered as active in biophosphorus conversion (Reddy et al., 2020).

5. Arbuscular mycorrhiza (AM) Fungi

Arbuscular mycorrhiza (AM) is the most common symbiotic association of plants with microbes. AM fungi occur in the majority of natural habitats and they provide a range of important ecological services, in particular by improving plant nutrition, stress resistance and tolerance, soil structure and fertility. AM fungi also interact with most crop plants including cereals, vegetables, and fruit trees, therefore, they receive increasing attention for their potential use in sustainable agriculture.

The beneficial effect on plant growth and yields following inoculation with AM is attributed to-

- Improved mineral nutrition, especially P (P, Zn, Cu, K, S, NH_4).
- Mobilization of nutrients through greater soil exploration.
- Protection of host roots against pathogen infection.
- Improved water relation.
- Better tolerance to stress like salinity, heavy metal pollution.
- Protection against transplantation shock.

6. Pink Pigmented Facultative Methylotrops (PPFM)

PPFMs are aerobic, Gram-negative bacteria and, although they are able to grow on a wide range of multicarbon substrates, they are characterized by the capability to grow on one-carbon compounds such as formate, formaldehyde, and methanol as their sole carbon and energy source. *Methylobacterium* sp. are classified as biostimulator. Biofertilizer and biocontroller as they directly influence the plant growth by producing phytohormones especially auxins, supply nutrients to the plants and induce systemic resistance in the plants against phytopathogens.

- Fasten seed germination and seedling growth.
- Accelerate vegetative growth.
- Increase leaf area index and chlorophyll content.
- Earliness in flowering, fruit set and maturation.
- Improves fruit quality, colour and seed weight.
- Yield increase by 10%.
- Mitigate drought.

Table 1: Utility of liquid microbial inoculants to different crops

Sl. No.	Crops	Microbial inoculants
1	Paddy	*Azospirillum*, *Azotobacter* and Phosphate Solubilizing Microorganisms (PSM)
2	Maize	*Azospirillum, Azotobacter* and *PSM*
3	Arecanut	*Azospirillum, Azotobacter* and *PSM*
4	Sugarcane	*Azospirillum, Acetobacter* and *PSM*
5	Coffee	*Azotobacter* and *PSM*
6	Cardamom and Pepper	*Azotobacter, PSM, Trichoderma* and *Pseudomonas*
7	Turmeric	*Azospirillum, Azotobacter, PSM, Trichoderma* and *Pseudomonas*
8	Ginger	*Azospirillum, Azotobacter* and *PSM*
9	Pulses	*Rhizobium, PSM, Trichoderma* and *Pseudomonas*

Liquid Biofertilizer Application Methodology

Seed Treatment

One kg of seed is treated with 15 ml of liquid biofertilizer mixed with 100 ml of rice gruel and shade dried for 30 minutes. The treated seeds should be sown within 24 hours.

Root Dipping

It is suitable for seedlings of vegetables and saplings of fruits where they are dipped in liquid culture of the microorganisms and then sown immediate. 200 ml liquid biofertilizer is mixed with 10 litres of water and roots of the seedlings meant for one acre are dipped in for 20 minutes and transplanted.

Soil Application

In direct inoculation beneficial microorganisms of biofertilizers are directly incorporated into soil. 250 ml of liquid biofertilizer is mixed with 1 litre of water and thoroughly mixed with 10 kg of powdered FYM / Soil and broad casted in an area of one acre.

Foliar Application

Microbial cultures in liquid form are sprayed over plants which are absorbed through stomatal pores or epidermal cells present on the leaf surface. Spray of 1% of liquid methylobacterium biofertilizer concentration either early morning or late evening.

Conclusion

Biofertilizer have an important role to play in improving nutrient supplies and their crop availability in the years to come. They are of environment friendly non-bulky and low cost agricultural inputs. A biofertilizer is an organic product containing a specific micro-organism in concentrated form which is derived either from the plant roots or from the soil of root zone (*Rhizozsphere*). Liquid biofertilizers have the capacity to replace the traditional chemical fertilizers & carrier based biofertilizers and plays a major role in restoring the soil health, but a lot of measures in terms of technology, government support, subsidies, and constructive awareness by well trained technicians among the agrarians are emphasize.

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