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Biofertilizers - A way to organic agriculture

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Abstract

Fertilizers supply essential plant nutrients, mainly Nitrogen (N), Potassium (K) and Phosphorus (P). These fertilizers increase the yield of the crop but they cause several health hazards. Due to several health hazards, consumer preferences shift towards the use of organic food grown without the use of any chemical. In India, the availability and affordability of fossil fuel based chemical fertilizers at the farm level have been ensured only through imports and subsidies. Today biofertilizers have emerged as a highly potent alternative to chemical fertilizers due to their eco-friendly, easy to apply, non-toxic and cost effective nature. Also they make nutrients that are naturally abundant in soil or atmosphere, usable for plants and act as supplements to agrochemicals. In addition, they are a product that is likely to be commercially promising in the long run once information becomes available adequately to producers and farmers through experience and communication. There is an on-going attempt to promote biofertilizers in Indian agriculture through public intervention and in keeping with the spirit of the times, these policies motivate private sector and the profit motivation will help propel the new technology. Government of India and various state governments have been promoting the nascent biofertilizer market both at the level of the user-farmer and the producer-investor.

Keywords: biofertilizers, organic agriculture

Introduction

The term biofertilizer represent everything from manures to plant extracts. These are those substances that contain living microorganisms and they colonize the rhizosphere of the plant and increase the supply or availability of primary nutrient and or growth stimulus to the target crop. There are numerous species of soil bacteria that colonize mainly in the rhizosphere of plants. These bacteria are collectively known as plant growth promoting rhizobacteria (PGPR). Some PGPR promote the growth by acting as biofertilizer. Microorganisms mainly nitrogen fixer, phosphate solubilizer and mycorrhizae are the main sources of biofertilizer. The microorganisms user for the biofertilizer are bacteria of *Bacillus*, *Pseudomonas*, *Lactobacillus*, photosynthetic bacteria, nitrogen fixing bacteria, fungi of *Trichoderma* and yeast. Biofertilizers have great potential as they are renewable and environmental friendly source of plant nutrient. Moreover they are ready to use and are used as a live formulation of beneficial microorganisms when it is applied to seed, root or soil, it mobilizes the availability of nutrients particularly by their biological activity and help to build up the lost microflora and in turn improve the soil health in general. Their mode of action differs and can be used alone or in combination. For easy application, biofertilizers are packed in suitable carrier such as lignite or peat. Carrier also plays an important role in maintaining sufficient shelf life.

Types of Fertilizers

The most essential requirements for plants are water and sunlight. Then there are the nutritional requirements in terms of micronutrients and macronutrients. The objective is to replenish the original fertility of the soil. The more intense the cultivation of that soil, the more intense the fertilization activities will have to be.

Fertilizers are generally divided into-

- Organic fertilizers
- Chemical fertilizers
- Biofertilizers

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Organic (Natural) Fertilizers

These types of fertilizers are plant and animal by-products and besides their capacity to fertilize soil (via- nitrogen, phosphorus and potassium) they contain carbon. Organic fertilizers originate from compost, manure or animal remains. Following are the major organic fertilizers-

- a) **Manures-** It is generally derived from equine or bovine digestion by products. It is an excellent natural fertilizer due to its nutritive properties for both cultivation and gardening.
- b) **Chicken Manure-** It is chicken excrement. Even this requires a process of transformation, where the chicken excrement is left to manure, or ferment then dried and granulated.
- c) **Leonardite-** It is derived from fossils and is also used for organic farming since it doesn't contain chemical substances. It improves soil quality, absorption capacity of nutritional elements and micronutrients, has invigorating and growth stimulating properties for plants and stimulates seed germination and root formation.
- d) **Blood Meal-** It is derived from bovine blood and is a fertilizer with high nitrogen content. It is excellent for vegetable gardens and acidophilic plant but since, it is derived directly from animals, it requires appropriate transformation process and should be used with caution.
- e) **Hoof and Horn-** It is derived from hooves and horns of animals. This type of fertilizer contains high levels of nitrogen that is beneficial to gardens, grass and evergreens. It is important to note that for all organic fertilizers, there are laws limiting the use due to the presence of heavy metals such as copper, zinc, chrome and lead. As organic fertilizers break down and improve the soil structure and thereby increase the ability of soil to hold water and nutrients. They do not harm the plants by overfertilizing as these are the ultimate slow release fertilizers. Also there is almost no risk of toxic build ups as organic fertilizers are renewable, biodegradable, sustainable and environment friendly. Apart from all the advantages mentioned earlier, there are some disadvantages also of organic fertilizers. Microorganisms are required to breakdown and release nutrients into the soil. Since they need warmth and moisture to do their job, the effectiveness of organic fertilizer is limited seasonally. They break down according to nature's rules, so they may not release nutrients as soon as you need them. Also their nutrient ratios are often unknown and the overall percentage is lower than chemical fertilizers. Some organic products are actually higher in certain nutrients.

Inorganic (Chemical) Fertilizers

These are the type of fertilizers which are produced industrially. These are nutritionally balanced as these are prepared by mixing macro and micronutrients in proportions based on desired plant requirements.

There are various types of chemical fertilizers such as-

- a) **Nitrogen rich-** they promote stem and leaf growth and is suitable for evergreens and grasses.
- b) **Phosphorus rich-** They stimulate root growth and is thus suitable for plant early growth. It is indicated mostly for flowering plants.
- c) **Potassium rich-** They stimulate flower and fruit growth and the formation of the lignifying protective layer of

stems.

Chemical fertilizers are obtained from extractions or from physical and or chemical processes. These are classified based on both the type of nutritional elements and the actual nutritional contents within the fertilizer.

Types of Nutritional elements

- a) **Principal nutritional elements-** Nitrogen, Potassium, Phosphorus
- b) **Secondary nutritional elements-** Calcium, Magnesium, Sodium and Sulphur
- c) **Micronutrients-** Boron, Cobalt, Copper, Iron, Manganese, Molybdenum, Zinc.

Nutritional contents

- a) **Simple fertilizers-** contain only one main nutritional element.
- b) **Mixed fertilizers-** contain at least two main nutritional elements.

74% of fertilizers are mostly made of Nitrogen and in some this rises to 90%. Nitrogen is by far the most used fertilizing element.

Chemical fertilizers have serious impacts:

- a) Producing chemical fertilizers consumes a lot of energy. Producing one ton of ammonia requires the equivalent of one ton of natural gas. The process also has a huge impact on carbon dioxide emissions, packaging waste, transportation and distribution from the few origins to the multitude of destinations worldwide. It is known as one of the most environmentally harmful production and distribution activities around the globe.
- b) The resources for producing fertilizers are also decreasing. c- The effect is also seen in case of aquifers where nitrates and herbicides, animal growth hormones and health effects on farm animals.
- c) There are also environmental problems due to eutrophication of water where the nutritional content in these environments increase causing algae to proliferate and consequently reduce the oxygen in water leading to harms of marine life.
- d) There are also some indirect effects like abandonment of mountain area agriculture, concentration of agriculture in few consolidated areas and increase in energy costs of transportation.
- e) They grow plants but do nothing to sustain the soil. The fillers do not promote life or soil health and even packages labeled as "complete" do not include the decaying matter necessary to improve soil structure.
- f) Because the nutrients are readily available, there is a danger of over fertilization.
- g) Chemical fertilizers tend to leach, or filter away from the plants requiring additional applications.
- h) Long term use can change the soil pH, upset beneficial microbial ecosystems, increase pests and even contribute to the release of green house gases.

Biofertilizers

Best defined as biologically active products or microbial inoculants i.e. formulation containing one or more beneficial bacteria or fungal strains in easy to use and economical carrier materials which add, conserve and mobilize crop nutrients in the soil. In other words, biofertilizer is a substance which contains living microorganisms which when applied to seed,

plant surfaces or soil colonize the rhizosphere or the interior of the plant and promotes growth by increasing the availability of primary nutrients to the host plant. Biofertilizers are more commonly known as microbial inoculants, are artificially multiplied cultures of certain soil organisms that can improve soil fertility and crop productivity. Although the benefits of legumes in improving soil fertility was known since ancient times and their role in biological nitrogen fixation was discovered more than 100 years ago. Biofertilizers play a very significant role in improving soil fertility by fixing atmospheric nitrogen both in association with plant roots and without it, solubilize insoluble soil phosphates and produces plant growth substances in the soil. Biofertilizers are the preparations containing cells of microorganisms which may be Nitrogen fixers, Phosphate solubilizers, Sulphur oxidizers or organic matter decomposers. In present times, a need has arisen for organic biofertilizers to minimize our dependence on fertilizer nitrogen. The experiments conducted in India and abroad on biofertilizers revealed that legumes i.e. beans, soybean, chick pea, pigeon pea can fix 50-500 Kg atmospheric nitrogen per hectare under ideal conditions of environment. Wrong and untimely applications of artificial fertilizers adversely affect the natural balance of soil crop ecosystems, microbial ecology and concern environment resulting in widespread decline in the crop yield. Therefore we have to curtail our dependence on chemicals and look for economical as well as environmentally viable technology. Therefore there is an upward trend in the demand for biofertilizers.

Dependence on chemical fertilizers for future agricultural growth would mean further loss in soil quality, possibilities of water contamination and unsustainable burden on the fiscal system. Consistent with current outlook, the government aims not only to encourage their use in agriculture but, also to promote private initiative and commercial viability of production. The government of India has been trying to promote an improved practice involving use of biofertilizers along with fertilizers. These inputs have multiple beneficial impacts on the soil and can be relatively cheaper and convenient to use.

Biofertilizers are used in live formulation of beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients particularly by their biological activity and help to build up the lost microflora and in turn improve the soil health in general. Their mode of action differs and can be used alone or in combination. For easy application, biofertilizers are packed in suitable carrier such as lignite or peat. Carrier also plays an important role in maintaining sufficient shelf life.

Types of Biofertilizer Available

1. Nitrogen fixing biofertilizer- *Rhizobium*, *Azotobacter*, *Azospirillum*, *Bradyrhizobium*.
2. Phosphorus solubilising biofertilizer- *Bacillus*, *Pseudomonas*, *Aspergillus*
3. Phosphorus mobilizing biofertilizer- *Mycorrhiza*
4. Plant growth promoting biofertilizer- *Pseudomonas*.

They fix nitrogen in the soil and the root nodules of the legumes crop and make it available to the plant. They solubilize the insoluble form of the phosphate like tricalcium, iron and aluminium phosphate into the available form. They produce hormones and antimetabolites which promote root growth. They also decompose the organic matter when biofertilizers are applied to the seed and the soil they

increases the availability of the nutrient to the plant and increases the yield upto 10-20% without producing any adverse effect on the environment.

Advantages of Biofertilizers

1. **Sustainability**- They increase the nitrogen and phosphorus available to plants more naturally than other fertilizer. They do not pollute the soil or the environment
2. **Affordability**- They reduce dependence upon expensive petroleum sources of chemical fertilizers. According to "Journal of phytology" demand for chemical fertilizers will exceed the supply by more than 7 million tons by 2020. The shortage of fossil fuels to produce chemical fertilizers may drive up prices beyond the reach of small users. Biofertilizers are cheap, easy to use alternative to manufactured petrochemical products.
3. **Soil enrichment**- Biofertilizers add valuable nutrients to the soil, especially nitrogen, proteins and vitamins. They take nitrogen from the atmosphere and phosphates from the soil and turn them into forms that plants can use.
4. **Improved plants**- They increase yield by upto 30% because of the nitrogen and phosphorus they add to the soil. The improvement in the soil texture and quality helps plants grow better during periods of drought. Biofertilizers help plants develop stronger root systems and grow better. They also reduce the effects of harmful organisms in the soil, such as fungi and nematodes.

Disadvantages of Biofertilizers

1. Biofertilizers require special care for long term storage because they are alive.
2. They must be used before their expiration date.
3. If other microorganisms contaminate the carrier medium or if grower use the wrong strain, they are not as effective.
4. The soil must contain adequate nutrients for biofertilizer organisms to thrive and work.
5. Biofertilizers complement other fertilizers but they can't totally replace them.
6. Biofertilizers lose their effectiveness if the soil is too hot or dry.
7. Excessively acidic or alkaline soils also hamper successful growth of the beneficial microorganisms. Moreover, they are less effective if the soil contains an excess of their natural microbiological enemies.

Conclusion

In modern agriculture, due to heavy usage of chemical fertilizers and harmful pesticides on the crops, sustainability of the agriculture system collapsed, cost of cultivation soared at a high rate, income of farmers stagnated and food security and safety became a daunting challenge. Indiscriminate and imbalanced use of chemical fertilizers especially urea, along with chemical pesticides and unavailability of organic manures has led to considerable reduction in soil health. Biofertilizers are becoming increasingly popular in many countries and for many crops. Often organic food is included to help the microbes get established. In India, soil fertility is diminishing gradually due to soil erosions, loss of nutrition, accumulation of toxic elements, water logging and unbalanced nutrient compensation. Organic manure and biofertilizers are the alternate sources to meet the nutrient requirements of crops. The role of biofertilizer in agriculture production is of great importance. Biofertilizers benefitting

the crops are *Azotobacter*, *Azospirillum*, *Phosphobacter*, *Rhodobacter* etc. Biofertilizers can also make plant resistant to adverse environmental stresses. The proper application and use of biofertilizers will not only have an impact on sustainable agriculture's economic development but it will also contribute to a sustainable ecosystem and the holistic well-being. If you wish to live in harmony with nature and make a lasting improvement in your own patch of earth for generations to come, biofertilizers outweigh organic and chemicals by leaps and bounds.

Can a shot of chemical fertilizer make your containers spill over with blossoms and give you the biggest tomatoes and greenest lawn in the neighbourhood? Absolutely, Just be sure you understand what is really happening to the earth under your feet, so that you will make your choice consciously.

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