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Impact of Bio-Fertilizers in Sustainable Agriculture

Efosa Mark H.

Department of Information Technology University of Ibadan, Nigeria.

ABSTRACT

The objective behind the application of Bio-fertilizers /microbial inoculants to seed, soil or compost pit is to increase the number and biological, metabolic activity of useful microorganisms that accelerate certain microbial processes to augment the extent of availability of nutrients in the available forms which can be easily assimilated by plants. Biofertilizers are the substances containing variety of microbes having the capacity to enhance plant nutrient uptake by colonizing the rhizosphere and make the nutrients easily accessible to plant root hairs. Biofertilizers are well known for their cost effectiveness, environment-friendly nature, and composition; hence, this study reviewed the impact of bio-fertilizer in sustainable agriculture. Although the bio-fertilizer technology is a low cost, ecofriendly technology, several constraints limit the application or implementation of the technology. The constraints comprise environmental, technological, infrastructural, financial, human resources, unawareness, quality, and marketing, among others. These different constraints in one way or other affect the technique at production, the marketing and the usage.

Keywords: Bio-fertilizer, Agriculture, Constraint, Technology, Sustainable

INTRODUCTION

Biofertilizers are microbial inoculants complemented with organic material, which are helpful microbials. Biofertilizers aid with organic waste recovery, introduce beneficial microbes, and produce organic matter, which provide more niches for useful indigenous microbes. By increasing population of the world the demand for the food is increasing rapidly (1). The food demand is also increasing in developed countries where the land resources are not contributing in crop production. Hence, as the population's daily food requirements increases, and in a bid to increase the capacity of the available land to produce food, the people move to application of chemical fertilizers to increase crop production. But the long application of chemical fertilizers adversely affects the environment (1). These chemicals accumulate in the water and also can the cause of eutrophication (2, 3). These chemicals also harm the soil fertility, decrease holding capacity of soil, increases the salinity and disparity in soil nutrients (1) hence, the need for bio fertilizers. Bio-fertilizers are used to decrease the bad impacts of low fertility on the soil , the impact of environmental stress and the effect of biotic stress such as pathogens and other microorganisms.(4). Bio fertilizers are the material that contain living microbes that applied on seed, surfaces of plants or the soil, formation of colonies the rhizosphere or the interior of the plant, and promote the growth of the plant by increasing the supply of primary nutrients or giving the availability of these to the host (5). The main interest going towards the application of these bio fertilizers are because of increase capacity of the nutrient uptake of the plants. Bio fertilizers are mostly used to increases the microbial activity which in return increases the availability of the nutrients which can be assimilated easily by the plants (6). Accordingly, the general use of chemicals as fertilizers is to meet the demand of fast growth and high amount of food supply but obviously these leads to damage of the environment (damaging microbial biota, killing friendly insects and increase in pH). The use of chemicals fertilizers make the crops susceptible to disease and also results in decease soil fertility (4). To feed the growing world population, there is need to increase the amount of agriculture and increase the productivity in such a way the it is useful and also show no bad effect on either environment and humans. As such, bio-fertilizer provide and help the plant in getting both macro and micro essential elements for growth and also help in supply of hormones and other organic element for plants (7). The application

of bio fertilizer is the most effective and natural way to keep the bio system active and working, as the microbes in soil provides nutrients to plants and helping the biodiversity maintains by improving the quality of soil.

THE NEED FOR BIO-FERTILIZERS

Many microorganisms are used typically as biofertilizers, including nitrogen-fixing cyanobacteria (Anabaena), nitrogen-fixing soil bacteria (Rhizobium, Azotobacter), AM fungi, and phosphate solubilizing bacteria (Pseudomonas sp.). The need for the use of Bio-fertilizers has arisen primarily due to two reasons i.e. though chemical fertilizers increase soil fertility, crop productivity and production, but increased / intensive use of chemical fertilizers has caused serious concern of soil texture, soil fertility and other environmental problems. Thus, use of Bio-fertilizers is both economical as well as environment friendly [8]. Therefore, an integrated approach of applying both chemical fertilizers and Bio-fertilizers is the best way of integrated nutrient supply in agriculture. Organic fertilizers (manure, compost, semi-compost) are also considered as Bio-fertilizers, which are rendered in available forms due to the interactions of microorganisms or their association with plants. Bio-fertilizers include

i) Symbiotic nitrogen fixers Rhizobium sp.
ii) Non-symbiotic, free living nitrogen fixers Azotobacter, Azospirillum etc.
iii) BGA-inoculants Azolla-Anabaena,
iv) Phosphate solubilizing microorganisms (PSM) Bacillus Pseudomonas, Penicillium Aspergillus etc.
v) Mycorrhiza
vi) Cellulolytic microorganisms and
vii) Organic fertilizers.

ROLE OF BIO-FERTILIZERS IN SOIL FERTILITY AND AGRICULTURE

Bio-fertilizers are known to play a number of vital roles in soil fertility, crop productivity and production in agriculture as they are eco friendly and cannot at any cost replace chemical fertilizers that are indispensable for getting maximum crop yields. Some of the important functions or roles of Bio-fertilizers in agriculture are:

- They supplement chemical fertilizers for meeting the integrated nutrient demand of the crops.
- They can add 20-200 kg N/ha year (eg. Rhizobium sp 50-100 kg N/ha year; Azospirillum, Azotobacter: 20-40 kg N/ha /yr; Azolla : 40-80 kg N/ha; BGA :20-30 kg N/ha) under optimum soil conditions and thereby increases 15-25 percent of total crop yield.
- They can at best minimize the use of chemical fertilizers not exceeding 40-50 kg N/ha under ideal agronomic and pest-free conditions.
- Application of Bio-fertilizers results in increased mineral and water uptake, root development, vegetative growth and nitrogen fixation.
- Some Bio-fertilizers (eg, Rhizobium BGA, Azotobacter sp) stimulate production of growth promoting substance like vitamin-B complex, Indole acetic acid (IAA) and Gibberellic acids etc. Phosphate mobilizing or phosphorus solubilizing Bio-fertilizers / microorganisms (bacteria, fungi, mycorrhiza etc.) converts insoluble soil phosphate into soluble forms by secreting several organic acids and under optimum conditions they can solubilize / mobilize about 30-50 kg P_2O_5/ha due to which crop yield may increase by 10 to 20%.
- Mycorrhiza or VA-mycorrhiza (VAM fungi) when used as Biofertilizers enhance uptake of P, Zn, S and water, leading to uniform crop growth and increased yield and also enhance resistance to root diseases and improve hardiness of transplant stock.
- They liberate growth promoting substances and vitamins and help to maintain soil fertility.
- They act as antagonists and suppress the incidence of soil borne plant pathogens and thus, help in the bio-control of diseases.
- Nitrogen fixing, phosphate mobilizing and cellulolytic microorganisms in bio-fertilizer enhance the availability of plant nutrients in the soil and thus, sustain the agricultural production and farming system.
- They are cheaper, pollution free and renewable energy sources
- They improve physical properties of soil, soil tilth and soil health in general.
- They improve soil fertility and soil productivity.
- Blue green algae like Nostoc, Anabaena, and Scytonema are often employed in the reclamation of alkaline soils.

- Bio-inoculants containing cellulolytic and lignolytic microorganisms enhance the degradation/ decomposition of organic matter in soil, as well as enhance the rate of decomposition in compost pit.
- BGA plays a vital role in the nitrogen economy of rice fields in tropical regions.
- Azotobacter inoculants when applied to many non-leguminous crop plants, promote seed germination and initial vigor of plants by producing growth promoting substances.
- Azolla-Anabaena grows profusely as a floating plant in the flooded rice fields and can fix 100-150 kg N/ha /year in approximately 40-60 tones of biomass produced.
- Plays important role in the recycling of plant nutrients.

METHODS OF BIO-FERTILIZER APPLICATION

Seed Treatment: 200 g of bio-fertilizer is suspended in 300-400 mL of water and mixed gently with 10 kg of seeds using an adhesive like gum acacia, jiggery solution, etc. The seeds are then spread on a clean sheet/cloth under shade to dry and used immediately for sowing.

Seedling Root Dip: This method is used for transplanted crops. For rice crop, a bed is made in the field and filled with water. Recommended bio-fertilizers are mixed in this water and the roots of seedlings are dipped for 8-10 h and transplanted.

Soil Treatment:

4 kg each of the recommended bio-fertilizers is mixed in 200 kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting.

Quality Control Measures (as per ISI Specifications)

- Since, Bio-fertilizers contains live cells, care should be taken during their transportation and storage.
- They should be kept in a cold place and not exposed to sunlight.
- Bio-fertilizers for legumes are crop-specific; therefore, they must be used for the crop for which they are meant.
- Bio-fertilizers when used under adverse soil conditions, appropriate remedial measures (liming and use of Gypsum) should be followed. Bio-fertilizers must be carrier-based.
- Carrier material used should be in form of powder (75-106 micron size.
- It should contain minimum of 10^8 viable cells of microorganisms /gram of the carrier material on dry weight basis.
- It should have a minimum period of six months expiry date.
- It should be tree from any contaminant /contamination with other microorganisms.
- PH should be in the range of 6.0-7.5.
- It should induce desired beneficial effects on all those crops, species /cultivars listed on the packet before the expiry date.
- It should be packed in 50-75 micron low density polythene packets

ADVANTAGES OF USING BIO-FERTILIZERS IN AGRICULTURE:

1. It is a low cost and easy technique.
2. The bio-fertilizers increase 15-35% additional yield in most of vegetable crops.
3. Besides fixing atmospheric nitrogen, cyanobacteria synthesize and excrete several growth hormones (auxins and ascorbic acid) and vitamins which enhance seed germination and growth of crop plants.
4. They do not cause atmospheric pollution and increase soil fertility.
5. Some biofertilizers excrete antibiotics and thus act as pesticides.
6. They improve physical and chemical properties of soil such as water holding capacity, buffer capacity etc.
7. Some of the biofertilizers enhance crop yield even under ill irrigated conditions where chemical fertilizers are of not much advantage. 8. They are ecofriendly and pose no danger to the environment

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 include [9]:

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 fertilizers.

CONCLUSION

In conclusion, microbial based fertilizers are very significant for the improvements crop. They are inoculants or carrier based preparations containing living or latent cells of efficient strains of nitrogen fixing, phosphate solublizing and cellulose decomposing microorganisms intended for seed or soil application and designed to improve soil fertility and plant growth by increasing the number and biological activity of beneficial microorganisms in the soil. So they are recognised as one of the components of integrated plant nutrients supply (IPNS). They are very safe to use for both environment, plants and animals and human and highly eco-friendly. Also, they ensure the sustainable growth of agriculture by providing the nutrition to plant in it rhizosphere such as N, P, and K and other minerals and vitamins.

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