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Biofertilizers for Organic Farming: Cyanobacteria Biofertilizer for Rice Cultivation – Establishment of Industry for Self Employment in Rural Areas

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ABSTRACT:- *Biofertilizers are ecofriendly, self replicating, cheap and easily manageable inputs which augment and increase the availability of crop nutrients. Biofertilizers increase the soil vitality. Nitrogen fixing biofertilizer***:** *For legumes - Rhizobium, and for cereal - Azotobacter, Azospirillum, Blue green algae (popularly known as BGA or cyanobacteria biofertilizer) and Azolla. Rhizobium biofertilizer can fix 50 to 200 Kg nitrogen per hectare per year. It increases yield by 25 to 30% of pulses and 40 to 80 Kg nitrogen is left over in the field for subsequent crop. BGA can add up to about 20 to 25 Kg nitrogen per hectare to rice field. BGA and also Azospirillum and Azotobacter supply growth regulators such as IAA, IBA, GA and vitamins to crop. Azolla not only supplied nitrogen but also increases organic matter in form of biomass and increases soil fertility. Of the various types of biofertilizers used, BGA and Azolla are used for rice cultivation, which is the principal crop of east and south India and Vidharbha of Maharashtra. In all, 120 species of heterocystous blue green algae belonging to Anabaena, Nostoc, Cylindrospermum, Calothrix, Rivularia, Aulosira, Tolypothrix, Scytonema, Hapalosiphon, and Westiellopsis and 23 non-heterocystous forms of the genera Oscillatoria, Lyngbya and Aphonothece were isolated and maintained in a germplasm collection.*

Under the lab to land programme for transfer of the technology to farmer's fields, outreach activities were carried in the villages of Sakoli taluka of Bhandara and Sindewahi taluka of Chandrapur districts of Maharashtra. For popularisation of the technology in the state, presently a laboratory has been set-up in a rural area of Maharashtra with the support of the Panjabrao Krishi Vidhyapeeth, Akola where mass multiplication of BGA biofertlizer using region specific strains is being carried out. Training programmes are organised to apprise farmers, NGO's and agriculture officials regarding production, quality testing and economics of the technology for entrepreneur development. BGA biofertlizer cultivated in poly-bags in the laboratory in cheap media were immobilised in coir or sterilized soil are supplied to farmers and entrepreneurs for mass multiplication and application in rice cultivation. During the tenure of the project any entrepreneur from the state can get the training and expert advice free of cost, to start individual BGA biofertilizer production units for self employment.

Key words : *C*yanobacteria biofertilizer, Nitrogen fixation*, Rhizobium, Azatobacter, Azospirillum.* Paddy field.

INTRODUCTION

Agriculture plays a pivotal role in the growth and survival of nations; therefore, maintaining its quantity and quality is essential for feeding the population and economic exports. Over the years, agriculture has undergone various scientific innovations in order to make it more efficient [1]. Agriculture plays a pivotal role in the growth and survival of nations; therefore, maintaining its quantity and quality is essential for feeding the population and economic exports. Over the years, agriculture has undergone various scientific innovations in order to make it more efficient [1]. From long-ago, the chemical pesticides and fertilizers have played a vital role in improving agricultural production. Although they have a short history in modern agriculture, their instant action and low cost managed to bring them quickly into the center of attention. Thus their adverse effects on environment, plant, animal and human life have diverted the priority on ecofriendly plant protection [11].

The term biofertilizer, depict everything from manures to plant extract [2]. Biofertilizer is a biotic constituent of specific microbial cells which when applied, stimulates plant growth by accelerating the rate of nutrient release through nitrogen fixation, phosphorus cycle etc. Increasing use of inorganic nitrogenous fertilizers in agriculture has resulted in degradation of soil quality including loss of beneficial microorganisms in the soil ecosystems. Use of chemical fertilizers resulted in mismanagement of nutrients in the soil. In the present agronomic practices production is higher due to use of fertilizers at the coat of available soil nutrients and microorganisms which largely recycle these. Hence biofertilizers [13] are now used in agriculture which is supplements to chemical fertilizers. Biofertilizers, now renamed as bioinoculants are ecofriendly, self replicating, cheap and easily manageable inputs which augment and increase the availability of crop nutrients.

DISCUSSION

Biofertilizers increase the soil vitality through [3, 4]:

1. Soil conditioning,

2. Addition of organic matter,

3. Salinity amelioration,

4. pH buffering,

5. Reduction of oxidizable matter content and

6. Provide fixed Nitrogen.

The materials of biological origin which are commonly used to maintain and improve soil fertility are grouped into two main categories:

1. Biofertilizers and

2. Green manures.

Both of these are used in agriculture to combat the ill effect of chemical fertilizers. Through intensive research and application trials it is now known that integrated nutrient supply systems to crop fields can be achieved by means of judicious combination of fertilizers, organic manures and biofertilizers to increase productivity and maintaining soil health of farm land.

The term biofertilizers or which can be more appropriately called "Microbial inoculants" are preparations containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic microorganisms used for application of seed, soil or composting areas with the objective of increasing the number of such microorganisms and accelerate certain microbial process to augment the extent of availability of nutrients in a form which can be easily assimilated by plants. In large sense the term may be used to include all organic resources for plant growth which are rendered in an available form for plant absorption through microorganisms or microorganism-plant associations or interactions.

Biofertilizers can be broadly classified into three categories [12]:

1. Nitrogen fixing biofertilizer [8]:

   (I) For legumes - *Rhizobium*, and

   (II) For cereal - *Azotobacter, Azospirillum*, Blue green algae (popularly known as BGA or Cyanobacteria) and *Azolla*.

2. Phosphate mobilizing biofertilizers:

   (I) Phosphate solubilizer – *Bacillus, Pseudomonas* and *Aspergillus,* and

   (II) Phosphate absorber – Mycorrhiza.

3. Cellulolyte or organic matter decomposers:

   (I) Cellulolytic – *Cellulomonas* and *Trichoderma*, and

   (II) Lygnolytic organism – *Arthobacter*.

Rhizobium biofertilizer can fix 50 to 200 Kg nitrogen per hectare per year. It increases yield by 25 to 30% of pulses and 40 to 80 Kg nitrogen is left over in the field for subsequent crop. BGA can add up to about 20 to 25 Kg nitrogen per hectare to rice field. BGA and also *Azospirillum* [1, 6, 7] and *Azotobacter* [10] supply growth regulators such as IAA, IBA, GA and vitamins to crop. *Azolla* [15, 9], not only supplied nitrogen but also increases organic matter in form of biomass and increases soil fertility. PSBs are highly useful to make unavailable form of phosphorus of soil to available form for crops.

Biofertilizers are applied in three different ways depending on the microorganism used and the crop for which they are applied [5],- **1**. In legume crops where seeds are being sown directly in the field crop specific microorganism is applied through seed treatment. Required quantity of culture in water are mixed to form a thick slurry on seeds to be treated, and mixed with hand till a uniform coating is obtained on all seeds. Seeds are dried in shade and sown. **2**. In crops where first nursery is raised and then seedlings are transplanted in the field, required quantity of culture in 5 liter of water is prepared. The roots of the seedlings to be transplanted are dipped for 2 to 3 minutes and then transplanted immediately. **3**. For broadcast required quantity of carrier based immobilized, live or latent microorganisms are either mixed with FYM or soil or broadcasted uniformly before or soon after transplanting.

A number of precautionary measures to be followed to get best result from biofertilizer application, e.g. (a) The entire process of seed inoculation and drying should be carried out in shade and preferably in the morning hours of the day, (b) Treated seeds should not be mixed with chemical fertilizers, (c) If the soil is acidic or alkaline, soil treatment should be done before application, (d) Biofertilizer packets should be kept away from direct heat and sunlight, and (e) most important [11]. – (**1**) specific biofertilizer for specific crop should be used, and (**2**) quality of the microorganism on the basis of presence of adequate viable cells in the biofetrtilizer packet before expiry to be used.

The constraints to effective exploitation of biofertilizer technology in India at present are:

- Unavailability of quality biofertilizers.
- Lack of awareness about the technology for extension workers and farmers.
- Non-existence of Entrepreneurs in this sector and lack of biofertilizer delivery system from production units to the farmer.

For success of biofertilizers in India, a holistic approach right from production, quality control, demonstration, field trial, entrepreneurship and efficient delivery system is required. With a changing agriculture scenario in the farm sector with serious problems of pollution of soils due to chemical fertilizer, pesticides and inappropriate plant nutrient application, it is now the urgent need to harness the benefit from biofertilizers for improving the productivity of soil and sustenance of soil health.

Of the various types of biofertilizers used, BGA (Cyanobacteria) and *Azolla* are used for rice cultivation, which is the principal crop of east and south India [14]. BGA biofertilizer (Cyanobacteria biofertilizer) demonstration and use was started in villages of Sakoli taluka of Bhadara and Sindewahi taluka of Chandrapur districts of Maharashtra state at the Panjabrao University of Agriculture and Technology during 1982. But since no quality control measure for BGA biofertilizer is taken by the state Government, it is not performing in the field as claimed, hence is not popular among the farming community of the state. With a view to provide authentic region specific strains in the BGA biofertlizer inoculum, distributional pattern of BGA in the rice field soils of 45 locations covering all the ten agroclimatic zones were explored. In all, 120 species of heterocystous blue green algae belonging to *Anabaena, Nostoc, Cylindrospermum, Calothrix, Rivularia, Aulosira, Tolypothrix, Scytonema, Hapalosiphon*, and *Westiellopsis* and 23 non-heterocystous forms of the genera *Oscillatoria*, *Lyngbya* and *Aphonothece* were isolated and maintained in a germplasm collection. Though maximum number of *Nostoc* sp. was recorded from rice field soils of the state, these were confined to irrigated and lowland areas. Species of *Calothrix, Aulosira* and *Westiellopsis* showed wider distribution in different agroclimatic zones.

Five species of BGA were selected for mass multiplication for using as biofertilizer on the basis of their occurrence in different agroclimatic zones, higher growth rate and nitrogenase activity, capability to grow at a wide range of pH and temperature, and relatively higher tolerance to pesticides and nitrogenous fertilizers. These were cultivated in galvanized iron trays and poly-bags in the outdoor for producing inoculation for field application. Competition of inoculated BGA strains with indigenous flora during the crop cycle and the regulatory role of fertilizers for their establishment in the soil based dried culture, fresh wet culture and urea supplemented plots was investigated. Most of the inoculated species competed successfully and established in the field contributing higher amount of fixed N_2 to the soil. Under the lab to land programme for transfer of the technology to farmer's fields, outreach activities were carried out. For popularisation of the technology in the state, presently a laboratory has been set-up in the University where mass multiplication of BGA biofertlizer using region specific strains is being carried out. Training programmes are organised to apprise farmers, members of youth clubs, NGO's and agriculture officials regarding production, quality testing and economics of the technology for entrepreneur development. BGA biofertlizer cultivated in poly-bags in the laboratory in cheap media were immobilised in coir or sterilized soil are supplied to farmers and entrepreneurs for mass multiplication and application in rice cultivation. During the tenure of the project up to April 2004 any entrepreneur from the state can get the training and expert advice from us free of cost to start individual BGA biofertilizer production units for self employment.

CONCLUSIONS

Thus, biofertilizers proves to be an effective way for supplementing the plants with soluble essential nutrients for the sake of good growth and commercial benefit. Cyanobacteria offer an economically attractive and ecologically sound alternative to chemical fertilizers for realizing the ultimate goal of increased productivity, especially in rice cultivation. In a wetland rice ecosystem, nitrogen fixation by free living cyanobacteria also significantly supplements soil nitrogen. Cyanobacteria offer an economically attractive and ecologically sound alternative to chemical fertilizers for realizing the ultimate goal of increased productivity, especially in rice cultivation. In a wetland rice ecosystem, nitrogen fixation by free living cyanobacteria also significantly supplements soil nitrogen.

In current agriculture practices, chemical fertilizers have reduced the fertility of soil, making it unsuited for raising crop plants. Additionally, the excessive use of these inputs has also led to severe health and environmental hazards such as soil erosion, water contamination, pesticide poisoning, falling ground water table, water logging and depletion of biodiversity. Biofertilizers spontaneously activates the microorganisms found in the soil in an effective and eco-friendly way, thereby gaining more importance for utilization in crop production, restoring the soils fertility and protecting it against drought, soil diseases and thus stimulate plant growth. Biofertilizers lead to soil enrichment and are suitable with long-term sustainability. Further, they pose no danger to the environment and can be substituted with chemical fertilizers. The application of bio-fertilizers can minimize the use of chemical fertilizers, decreasing environmental hazards, enhance soil structure and promote agriculture. Biofertilizers are cheaper and remarkable in affecting the yield of cereal crops. Bio-fertilizers being important components of organic farming play a key role in maintaining long term soil fertility and sustainability by fixing insoluble P in the soil into forms available to plants, thus increasing their effectiveness and availability. In context of both the cost and environmental impact of chemical fertilizers, excessive reliance on the chemical fertilizers is not a useful strategy in the long run due to the cost, both in domestic resources and foreign exchange; participate in setting up of fertilizer plants and maintaining the production. Biofertilizers are the alternative sources to meet the nutrient requirement of crops. In Biofertilizers, beneficial bacteria are *Azotobacter, Azospirillium, Rhizobium*, Mycorrhizae which are very essential in crop production. Biofertilizer can also make plant resistant to unfavorable environmental stresses.

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