PGPR Bioformulation for Plant Growth Promotion

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ABSTRACT

Soil is dynamic living matrix and it is not only a critical resource in agricultural and food security but it is also towards maintenance of all life process. Pathogenic microorganisms along with chemical fertilizers affecting plant health and environment are a major and chronic threat to sustainable agriculture and ecosystem stability worldwide. The practice indiscriminate use of chemical fertilizers in the agriculture to increase yields, kill pathogens, pests, and weeds, have a harmful impact on the ecosystem. Because of current public concerns about the side effects of agrochemicals, PGPR have gained a supreme attention in field of agriculture for plant growth promotion along with their environment friendly nature for sustainable agricultural practices. The use of plant growth promoting Rhizobacteria bioformulation in agriculture is a better alternative to resolve this ongoing problem. PGPR play an important role in direct or indirect way to increase in soil fertility, plant growth promotion, and suppression of phytopathogens for development of eco-friendly sustainable agriculture.

I INTRODUCTION

In agriculture field of many countries, for the plant growth promotion and suppression of plant diseases, for the better growth and yield, Indiscriminate use of chemical fertilizers may lead to toxic residues, development of fungicide resistance, environmental contaminations and carcinogenic, teratogenic and mutagenic effects in humans, animals and plants. Rhizosphere bacteria that favourably affect the plant growth and yield of commercially important crops are dominated as "plant growth promoting rhizobacteria. Several mechanism of plant-microbe interaction may participate in the association and affect the plant growth, including, 'N'-fixation, hormonal interaction, improvement in root growth, solubilization of nutrients, ACC-deaminase (acd) production and ethylene modulation at rhizosphere level, alleviation of soil salinity and biocontrol against phytopathogens. Thus, the PGPR affect the plant growth directly by producing and secreting plant growth promoting substances or eliciting root metabolic activities by supplying biological fixed nitrogen and indirectly by acting against phytopathogenic microorganisms Lugtenberg. An agricultural bioinoculant is a formulation containing one or more bacterial strains or species in an easy-to-use form. Higher degree of stress tolerance, long shelf life, enhanced survivability in soils and on seeds and consistent plant response to inoculation are the important characteristics of any agricultural bioinoculant. Okon (1994), suggested the importance of the physiological status of microorganisms in agricultural bioinoculant preparation rather than the cell numbers to ensure more survival in carriers, survival in soil and on seed, colonization in the rhizosphere and positive plant response to bioinoculation. When PGPR are mixed with some other PGPR strains, bacterial or fungal antagonists the biocontrol efficacy may be increased. Mixing mineral or organic carriers with the PGPR has also been found to increase the biocontrol efficacy. Moreover, the bioinoculant formulation has a crucial effect on the inoculation processes as the chosen formulation determines the potential success of the inoculants. In the last few years, several new agricultural bioinoculant formulations have been proposed. Efficient delivery system of bioformulation plays a vital role in the performance of the rhizobacterial strains in field conditions (Vidhyasekaran and Muthamilan 1999) There is growing interest in the use of biological approaches to replace chemicals in fertilizing soils or improving plant resistance against phytopathogens. In this regard plant growth promoting rhizobacteria (PGPR) have a potential role.

II BIOFORMULATION

Bio formulations are best defined as biologically active products containing one or more beneficial microbial strains in an easy to use and economical carrier materials. Usually, the term bioformulation refers to preparations of microorganisms. Formulations included a talc-based powder and bentonite-based powder as mineral carriers and peat and rice bran as organic carriers for increasing stability in interaction between PGPR and cotton plants.

(a) Development of talc based bio-formulation: Talc based bioformulation of the PGPR strains and Antifungal isolates were prepared by the following method. Loopful of individual strains were inoculated in individual nutrient media and incubated in shaker incubator at 120 rpm for 48 hr at 28±2°C. After incubation, the cells were pelleted and the cells were suspended in 10mM phosphate buffer saline (PBS) (pH 7.4) and the concentration of the cells were adjusted to 9×108 cfu/ml. Equal volume of the bacterial suspension containing 9×108 cfu/ml were mixed. One kilogram of talc was taken in a sterile

metal tray and the pH of the talc is neutralized by adding 15 g/kg (w/w) CaCO3. Ten gram of Carboxy Methyl Cellulose (CMC) was added to the 1 kg talc as adhesive and mixed well. This talc, CaCO3 and CMC mixture were autoclaved for 30 min on each of 2 consecutive days. To 1 kg of sterile Talc CMC carrier, 400 ml of the cell suspension mixture was added and mixed thoroughly under aseptic conditions. The talc formulation was shade dried overnight under sterile conditions and packed in sterile polypropylene bag, sealed and stored at room temperature (25±2°C)

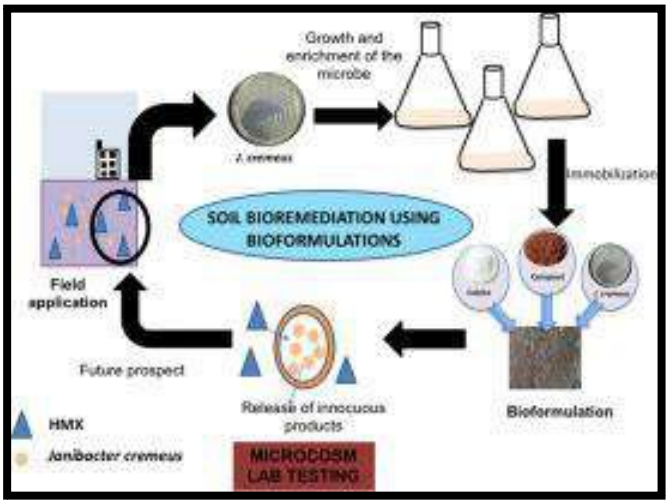

Fig: Microcosm Lab Testing

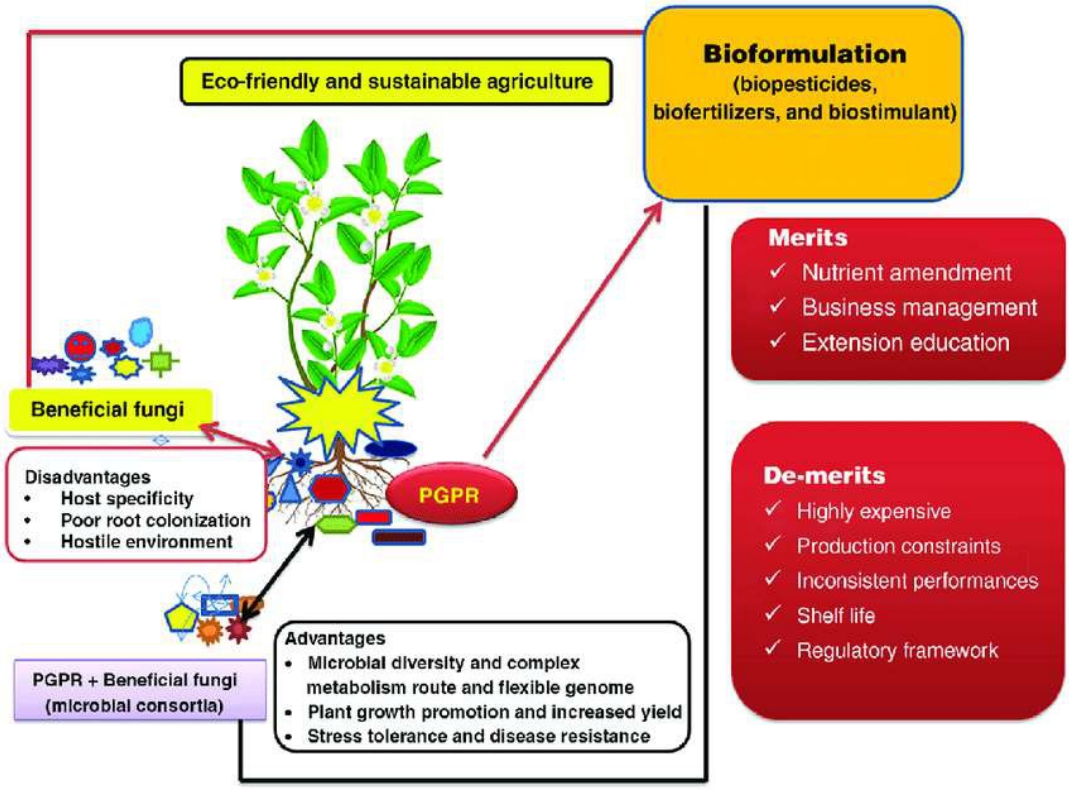

Fig. 2 Researchgate.net/figure/Research-and-development-strategies-for-bioformulation

(b) Bio-formulation and shelf life studies of bacterial: strains Bio-formulations of selected bio-fertilizer were obtained by mixing broth culture with previously sterilized fly-ash. These were packed in low density polythene pouch and stored at 28±2°C and room temperature. Shelf-life of the formulations was studied by drawing samples at regular interval of 30-days up to nine months from date of mixing and the colony forming unit (cfu) was counted by serial dilution agar plate method.

(c) Advantages of bio fertilizer over chemical fertilizer: A biofertilizer is not just any organic fertilizer or manure. It consists of a carrier medium rich in live microorganisms. When applied to seed, soil or living plants, it increases soil nutrients or makes them biologically available. Biofertilizers contain different types of fungi, root bacteria or other microorganisms. They form a mutually beneficial or symbiotic relationship with host plants as they grow in the soil. Biofertilizers have many advantages.

(d) Sustainability: Biofertilizers increase the nitrogen and phosphorus available to plants more naturally than other fertilizers.The different varieties available allow growers to tailor the microorganisms used to the needs of particular plants. Biofertilizers are simple to use, even for novice small growers. Biofertilizers do not pollute the soil or the environment, whereas chemical fertilizers often result in too much phosphate and nitrogen in the soil. The excess then leaches into lakes and streams through runoff. Waters decline in quality and suffer from overgrowth of algae and the death of fish. Affordability Biofertilizers reduce dependence upon expensive petroleum sources of chemical fertilizers. According to the "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 a cheap, easy-to-use alternative to manufacture petrochemical products.

(e) Improved Soil: Biofertilizers restore normal fertility to the soil and make it biologically alive. They boost the amount of organic matter and improve soil texture and structure. The enhanced soil holds water better than before. 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. Some species also produce natural pesticides.

(f) Improved Plants: Biofertilizers increase yield by up to 30 percent because of the nitrogen and phosphorus they add to the soil. The improvement in soil texture and quality helps plants grow better during periods of drought. Biofertilizers help plants develop stronger root systems and grow better. Biofertilizers also reduce the effects of harmful organisms in the soil, such as fungi and nematodes. Plants resist stress better and live longer.

Table 1
Difference between chemical fertilizer and bio fertilizer

Characteristic	Chemical Fertilizer	Biofertilizers
Source	Chemicals like rock phosphate, pyrite & gypsum deposits	Rhizospheric plant growth promoting microbes
composition	The Chemical fertilizer mainly comprises of Sulphur, Potassium, Phosphorus, Nitrogen, Magnesium and Calcium.	Microbial secretion like IAA production siderophoreproduction, Sulphur, Potassium, Phosphorus, Nitrogen, Magnesium and Calcium.
Effect on soil fertility	The use of chemical fertilizer in the farm land will give instant result but reduces the soil fertility.	Its effect on restoring soil fertility is longer-lasting when compared to chemical fertilizer
Destruction of beneficial microorganism	The synthetic chemicals in the chemical fertilizers adversely affects the naturally found soil microorganisms by affecting the soil pH	The use of biofertilizers for the plant for gardening or farm land will increase the population of microbes like actinomycetes, azotobacter, phosphate solubilizing microorganisms, mesophilic cellulose decomposing microorganisms and spore-forming bacteria which are helpful in maintaining the soil fertility
Air pollution	While manufacturing the chemical fertilizer harmful gases are released into the atmosphere and thereby causing air pollution. Emission rate CO2 500 kg/MT of Ammonia, NOx 0.5- 0.6 kg/MT of Ammonia.	It is 100% pollution free process. The greenhouse gases generated by anaerobic digestion are used for thermal or power generation.

Impect on human health	Chemical fertilizer enters the human body in three ways – passes through mouth, infiltrate through skin and while breathing. Moreover, chemical fertilizer causes critical health hazards to people such as skin cancer, effects on the growth of a baby.	Fertilizer from the biogas plant does not affect the nutrient value of the crops in any way. Hence, there are no chances of health hazards at all.
cost	Expensive	As long as you have wet organic waste you can generate your own bio fertilizer at your home easily absolutely free of cost.
Yield	Give instance result by increasing the yield. But on long run, it leads to soil infertility.	Gradual & sustainable increase in the yield is achieved by improving the soil fertility.

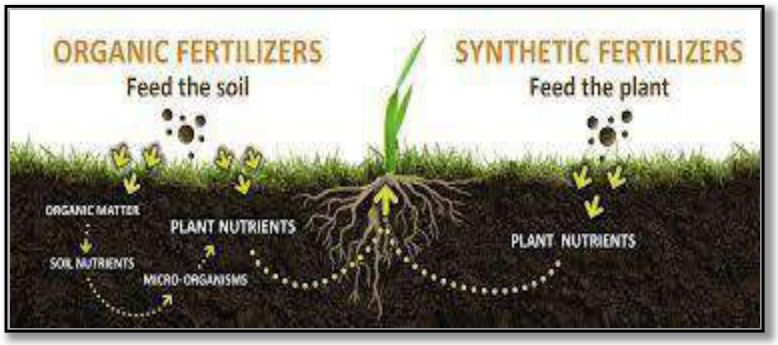

Fig. 3 https://www.milorganite.com/lawn-care/organic-lawn-care/organic-vs-synthetic

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