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# **Bio-Fertilizers Improves Soil Health and Crop Productivity**

**Soil health is a serious concern for sustainable crop production because of the magnitude of chemical fertilizers non-judiciously applied in agricultural crops. Besides this, the availability of organic soil carbon content is also decreasing very fast. For the management of soil organic carbon, the addition of agricultural waste and other organic material is an immediate requirement. For the management of chemical fertilizers, reduction in chemical fertilizers application can be done through the application of bio-fertilizers. Bio-fertilizers are live microbial formulations and have the potential to solubilise, mobilize and even fix plant nutrients for the benefits of crop plants. Besides this, bio-fertilizers are reported for increasing crop growth and yield. In India, a large number of bio-fertilizers are being produced at Govt. institutions/organization, state agricultural universities, NGOs and private agencies. Quality of bio-fertilizers should be procured, and applied in agricultural crops at a proper rate and method. In this article, we have here tried to provide basic information on bio-fertilizers and application in sugarcane crop.**

## **INTRODUCTION**

Drastically increasing human population directly or indirectly is affecting the availability of natural resources like land, air, and water. To feed the growing population, the quantity of agricultural produce is being produced. Cereals and pulses play a major role. Besides this, the quantity of sugar is needed to produce from sugarcane as well as other sugar crops. In India, sugarcane is one of the important cash crops and cultivated in both tropical and subtropical regions of the country. The crop requires a hot and humid climate for better growth and development. The crop takes around 10 to 18 months for maturity. Due to the long-duration nature of the crop, it requires proper

management of insect-pest, diseases, and weeds. Soil nutrients play a significant role in better growth and development. Timely application of fertilizers is a very crucial factor to achieve higher cane yield and juice quality but indiscriminate use of inorganic fertilizers has polluted our crop fields and depleted beneficial microbial population. Depleting beneficial microbial populations directly or indirectly is affected soil fertility. At the same time, it also increases crop production costs to a greater extent. Soil fertility is basically determined by the presence of beneficial microbial diversity. Therefore, to minimize the detrimental effect of inorganic fertilizers and reduce our dependency on them, the introduction of beneficial microorganisms for solubilization, mobilization, and fixation of plant nutrients is a very economical and viable approach for farmers.

### SOIL HEALTH

There is global demand for sustainable, ecologically compatible agricultural practices and techniques for providing quality and quantity food for increasing human population without any adverse effect on soil fertility and the environment. Soil is base for all living organisms starting from micro-organisms to macro-organisms. To fulfill the needs of a growing population, indiscriminate chemical fertilizers are being applied. These chemical fertilizers have badly affected soil quality as well as soil fertility. For sustainable crop production, soil quality must be improved urgently. Earlier FYM application and crop rotation were adopted to maintain soil quality. A number of agronomic practices have been identified to increase crop production and productivity simultaneously improving soil quality. Due long term use of chemical fertilizers, the soil becomes very poor in nutrients availability. So far, eight major nutrients become deficient in the soil. Besides this, the soil is also becomes contaminated with heavy metals especially mercury, arsenic, lead, etc., Population of beneficial microbes is depleting very faster rate. Organic carbon content is also under severe deficit condition. Soil health is required to be revitalized as soon as possible for sustainable crop production. It is well known to all of us that good soil health (consist beneficial microbes and organic carbon) produces more crop yield and also improves farmer's economic status.

### BENEFICIAL MICROBES

Due to reduced microbial biodiversity and soil nutrients in the soil, inoculations of beneficial microbes are required immediately. Because, beneficial microbes have a close association, relationship, and interaction with crop plants. Beneficial microbes are named according to their effect as well as existence. Some microbes support plant growth by performing a number of attributes called plant growth-promoting rhizobacteria (PGPRs). Some microbes help in the fixation of atmospheric nitrogen called biological nitrogen-fixing bacteria. Usually plant growth-promoting microbes solubilize, mobilize and fix soil nutrients, produce phytohormones like biomolecules, activation plant defense compounds, production of antibiotics as well as hydrolytic enzymes. Besides this, some microbes have the potential to chelate soil nutrients and or oxidized 1-aminocyclopropane-1-carboxylate (ACC) compounds that are immediate precursors of ethylene. Ethylene is a stress hormone. Keeping the importance of beneficial microbes, microbial bio-formulations have been developed from various research organizations for various agricultural crops like rice, wheat, maize, sugarcane, tomato, potato, chickpea, pea, and many more.

### BIO-FERTILIZERS

Bio-fertilizers are ready to use the live microbial formulation of beneficial microorganism which on application to seed, root, or soil helps in mobilization, solubilization and fixation of the plant nutrients by their biological activity and also help in building up the micro-flora and thus improves soil health.

### WHY SHOULD WE USE BIO-FERTILIZERS?

Modern agriculture is dependent upon the supply of chemical fertilizers, which are becoming scarcer and more costly? These are major agents for polluting soil and water etc. This situation has led to identifying harmless inputs like bio-fertilizers in crop cultivation, which not only helps in saving chemical fertilizers but also safeguards soil health and quality of crop products.

### BENEFITS FROM USING BIO-FERTILIZERS

Application of beneficial microbes increases crop yield up to 10-30%. Beneficial microbes are the cheapest, viable approach to replace chemical

fertilizers (inorganic fertilizers) up to 25% without any compromise in crop performance. These also stimulate plant growth and defense system activates soil biologically active phenomenon, restore natural soil fertility and microbial population, provide protection against biotic and abiotic stresses and ultimately application friendly and environmentally safe.

#### TYPES OF BIO-FERTILIZERS AVAILABLE

Bio-fertilizers are identified for their specific traits like microbes which has the potential to fix atmospheric nitrogen called Nitrogenous biofertilizers. Nitrogen-fixing microbes have been identified and characterized. These are *Rhizobium* spp., *Gluconacetobacter* spp., *Azotobacter* spp., *Azospirillum* spp., *Cyanobacteria* (Blue-Green Algae), *Azolla*, etc. Similarly, some beneficial microbes solubilize and mobilize soil fixed phosphate which is not accessible to the crop plants. The phosphorus solubilizing bio-fertilizers contain *Bacillus* spp., *Pseudomonas* spp., *Aspergillus* spp., VAM fungi/*Mycorrhiza*, etc.

#### CHARACTERISTICS OF QUALITY BIO-FERTILIZERS

Bio-fertilizers should have increased shelf-life/viability for effectiveness, better rhizosphere competence, ease for mass multiplication, a broad spectrum of action, tolerate desiccation, heat, oxidizing agents, and UV radiations and finally safe to the environment.

#### APPLICATION OF SUGARCANE IN BIO-FERTILIZERS

Nitrogenous bio-fertilizers - *Gluconacetobacter* bio-fertilizers is a product with a superior strain of *Gluconacetobacter diazotrophicus*. It is an endophytic bacteria i.e. associates and colonizes within all parts of sugarcane (root, cane stem, and leaves). It fixes atmospheric nitrogen and enhances the availability of nitrogen to sugarcane and also produces growth hormone-like Indole Acetic Acid (IAA). Its results are visible after 5-6 weeks of its application. It increases the size and length of internodes, enhances plant growth and development, and improves cane yield (5-15 t/ha). *Azotobacter* bio-fertilizers are a product with a potent strain of *Azotobacter chroococcum*. It is a free-living bacteria. It enhances the availability of nitrogen and also produces plant growth regulators. Thus stimulates rooting, excretes antibiotics

/bacteriocins, which protect root plant pathogens. It stimulates early seedling vigor and improves yield up to 20%. *Azospirillum* bio-fertilizer is a product with strains of *Azospirillum brasilense* or *Azospirillum lipoferum*. It is an associative type of bacteria, living in proximity to the root zone. It Fixes atmospheric nitrogen and provides 30-50% of the Nitrogen requirement and also produces plant growth hormones like auxins and cytokinins. It enhances germination efficiency, early seedling vigor, plant immunity, and cane yields up to 20 %.

#### PHOSPHATE SOLUBLIZING MICROBES (PSM)

Phosphate solubilizing bio-fertilizers is a product with a single or consortium of *Bacillus* spp., *Pseudomonas* spp., and *Aspergillus* spp., etc., It multiplies rapidly around the root zone, acts on inorganic bound soil phosphate, and makes phosphorous available to the plant. It improves plant vigor and yields up to 15%.

#### RATE AND MODE OF BIO-FERTILIZER APPLICATION IN SUGARCANE

Bio-fertilizers should be applied in proper quantity as well as mode depending on the bio-formulation nature. In the case of solid bio-formulation, 5 kg/acre or 12-15 kg/ha is to be done. In the case of liquid bio-formulation, 1 liter/acre or 2.5 liter/ha is sufficient. In liquid bio-formulation, required suspension ( $10^7$ cfu/ml) is prepared in sterilized distilled water at the time of sett or soil application. In the case of soil bio-formulation, based on application mode/method, solid bio-formulation is prepared. In sett treatment method, suspend and mix thoroughly 5 kg solid bio-fertilizers (for one acre) in 100 liters of water. Treat sugarcane setts by dipping at least 30 minutes in this suspension before planting. In soil treatment, suspend 5 kg of solid bio-fertilizers in 10 liters of water and mix thoroughly with 80-100 kg of Farm Yard Manure. The mixed bio-fertilizers in FYM is spread over cane setts in the rows at the time of planting. Immediately rows should be covered with soil. In nitrogenous bio-fertilizers either they are solid or liquid form. The application must be done through sett treatment.

#### PRECAUTIONS FOR USING BIO-FERTILIZERS

Bio-fertilizers packets should be stored in a cool and dry place or keep away from direct sunlight and heat. Do not mix bio-fertilizers simultaneously with inorganic fertilizers/pesticides/agrochemicals. Bio-

fertilizers packet should have the name of the product, crop for which intended, date of manufacture and expiry, batch number, instructions for use, name, and address of the manufacturer, to be taken. Bio-fertilizers packet should be used before its expiry date in described method and doze. For better results, bio-fertilizers should be used in combination with inorganic fertilizers (maintain application time gap) and should keep away children's reach.

#### **PROBABLE REASONS FOR GETTING POOR RESPONSE USING BIO-FERTILIZERS**

Reasons may be due ineffective microbial strain in microbial bio-formulations, insufficient microbial populations to survive and effect, and high levels of contaminants with other harmful or saprophytic microbes. It may have been exposed to high temperatures or sunlight during storage and application. It may not be followed recommended method and dosage of microbial inoculants or used along with inorganic fertilizers/pesticides/ agrochemicals. It may be used prevailing high soil temperature or low soil moisture or organic content. It may be used in high acidity or alkalinity-containing crop field.

#### **CONCLUSION**

Good soil health provides better crop growth and ultimately better crop yield. It is an urgent need to increase and maintain the diversity of beneficial microbes in the crop fields. Soil microbial activity and its distribution are either directly or indirectly affected by the presence of inorganic fertilizers/agrochemicals/soil organic content and environmental conditions. Bio-fertilizers are the best option to maintain soil nutrients. Bio-fertilizers have been developed and are being applied on large scale mainly in developed countries on different agricultural crops. Recently, developing countries have considered its effect and increases use of bio-fertilizers for improving soil health, crop productivity, and also safeguarding the environment.