



## Biofertilizer as Panacea to Agricultural Pollution

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### ABSTRACT

*The excessive usage of chemical fertilizers, containing heavy metals and radionuclides, has resulted in severe consequences that disrupt the ecological balance of the environment. This, in turn, poses life-threatening risks to plants, animals, and humans. Indiscriminate application of fertilizers to the soil leads to soil pollution, causing acidification, erosion, infertility, and ultimately, reduced crop yields. To address these issues, a global shift towards sustainable agricultural practices has emerged, with biofertilizers leading the way as the best alternative to chemical fertilizers. Biofertilizers consist of microorganisms inoculated in carriers, which can be applied directly to plant roots and leaves or to the soil. These microorganisms, such as Rhizobium, Pseudomonas, Lactobacillus, Enterobacter, Azospirillum, Azotobacter, Trichoderma, Penicillium, Aspergillus, and cyanobacteria, serve as beneficial biofertilizers. The unique capabilities of these microorganisms include atmospheric nitrogen fixation, inorganic phosphate solubilization, stress alleviation in plants, and imparting disease resistance, among other functions. Notably, biofertilizers have demonstrated tremendous potential in bioremediation efforts to restore polluted soils. Aside from their eco-friendly nature, biofertilizers are also cost-effective and simple to process. Additionally, they exhibit several beneficial effects on plant crops, contributing to healthier and more sustainable agricultural practices.*

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### INTRODUCTION

World population is increasing rapidly and this has led to increase in food demand, in order to meet up on with the high demand there is excessive use of chemical fertilizers to obtain high yield. The enormous use of these chemical fertilizers has gradually damaged the environment and causes harmful effect on living organisms, man included (Mahanty, et al., 2016). The main constituents of chemical fertilizers are Nitrate, phosphate, potassium and ammonium salts, heavy metals such as Copper, Nickel, Cadmium, Mercury and radionuclides like <sup>238</sup>U, <sup>210</sup>PO and <sup>232</sup>Th are also found in high concentrations in chemical fertilizer (Savci, 2012).

Most of the chemicals are partially absorbed by the plants and so there is gradual accumulation in the soil. The accumulated chemicals are washed into water bodies leading

to eutrophication, leaching into groundwater, emission of greenhouse gases (such as nitrous oxide and ammonia) (Ajmal, et al., 2018). Some of the hazardous effects of these chemicals are decrease in soil fertility, increased salinity, development of insect and disease resistance, disparity in soil nutrients and drought (Ajmal et al., 2018) (Mahanty, et al., 2016).

Indiscriminate use of chemical fertilizers has caused deleterious effects on soil, water and air (Mahanty, et al., 2016). Chemical fertilizers contain high amount of Nitrogen and potassium which leads to Eutrophication in surface water bodies. Nutrients from fertilizers stimulates uncontrollable microbial growths leading to reduction of dissolved oxygen and death of aquatic animals and plants, unpleasant odor and appearance of water. Others effects of fertilizer to water are ammonia toxicity and faecal contamination (Savci, 2012).

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Too much application of nitrogenous fertilizers contributes to air pollution resulting to greenhouse effects and acid rain which affects air quality and soil composition (Savci, 2012). Adverse effects caused by these chemicals are increase in salinity, disparity in soil nutrients, depletion in water holding capacity and soil fertility (Mahanty, et al., 2016).

The present challenge of the toxic effects of Agrochemicals on the environment and human health has given rise to the need for a safe and sustainable approach in Agricultural practices (S. Tomer et al., 2016). Bio-fertilizers are great alternative and has been proven by many researchers to be eco-friendly and sustainable in addressing the Agrochemical challenges. Bio-fertilizers are substances which contain living Microorganisms applied to the seeds, soil and plant surfaces that are colonized in the plant and promotes plant growth by improving nutrient accessibility (Muraleedharan, et al., 2010). Bio-fertilizer are inoculants containing bacteria, algae, Fungi individually or combined (Vishwakarma and Soni, 2018).

#### NEEDS FOR BIOFERTILIZERS

Bio-fertilizers are beneficial in the sense that they improve soil fertility, produce plant growth stimulants, improve mycorrhiza interactions, are capable of nutrient exchange and recycling in soil, develop bioremediation activities in contaminated soil, promotes bio-control and have biodegradation properties. In addition, biofertilizers are eco-friendly, cost effective, have long shelf-life and easier to process (Ajmal, et al., 2018).

#### Types of Biofertilizers

##### Nitrogen Fixers

Nitrogen is an important element in plant growth and productivity (Tomer, et al., 2016). 78 percent of nitrogen in the atmosphere is unavailable for plant utilization. The atmospheric nitrogen has to be converted to ammonia by microorganisms known as Nitrogen Fixers for plants to absorb (Mahanty, et al., 2016). These nitrogen fixers are classified into;

Symbiotic nitrogen fixers – they establish a symbiotic relationship with leguminous plants, examples are *Rhizobium*, *Bradyrhizobium*, etc.

Non-symbiotic (free-living/ associative) nitrogen fixers – they give little

percentage of nitrogen fixed to the plant, examples are *Azospirillum*, *Azotobacter*, *Klebsiella*, *Clostridium*, *Cyanobacteria* (*Nostoc*, *Anabaena*), etc. (Tomer, et al., 2016).

##### Phosphate Solubilizers

Phosphorus is mainly available in an inorganic form and has to be mineralized into soluble forms available for plant absorption (Mahapatra, et al., 2018). It makes up about 0.2% of plant dry weight and functions as promoter of crop yield and quality. Phosphate Solubilizers act by synthesizing organic acids which tricalcium phosphate to di and monocalcium phosphate forms readily available to plants. These organic acids include citric, gluconic, fumaric, Ketobutyric, glyoxylic, lactic and, 2-ketogluconic acids. *Pseudomonas* and *Bacillus* genera and fungi are among the microbes capable of phosphate solubilization (Mishra, et al., 2013).

##### Potassium Solubilizers

Potassium is the second- largest macronutrient utilized by plants after Nitrogen. Potassium aid plants in water, and nutrient uptake into plant tissues, buildup- of proteins and activation of enzymes. These are rhizospheric microbes capable of solubilizing and mobilizing insoluble potassium compounds by production of organic acids into available forms for plants (Bahadur, et al., 2014). Microbes varying from bacteria, fungi and actinomycetes are capable of potassium transformation (Kumar & Kumar, 2019).

##### Plant Growth Promoters

These are bacteria, fungi and, algae that colonize the rhizosphere and roots, they are important in inducing growth in plants. Plant Growth Promoting Microorganisms (PGPM) stimulate growth by fighting plant diseases, improving nutrient absorption and secreting phytohormones (Kumar, et al., 2017). Examples of PGPM are *Pseudomonas* sp. which acts by producing phytohormones and anti-metabolites which aid in the decomposition of organic matter and promote plant root growth (Ju, et al., 2018). How Plant Growth Promoting Microorganisms enhance the nutrient status of host plants can be categorized into five areas: (1) biological N<sub>2</sub> fixation, (2) increasing the availability of nutrients in the rhizosphere, (3) inducing increases in root



surface area, (4) enhancing other beneficial symbioses of the host, and (5) combination of modes of action (Vessey, 2003).

### EFFECT OF INTEGRATED BIOFERTILIZERS ON CROP YIELD

Biofertilizers play vital role to enhance the growth as well as the yield of crop plants. They involve in various biotic activities and sustainable for crop production. Biofertilizers play an important role in the growth of plants (Kumar & Urmilla, 2018). Single application of *Azotobacter* and *Mycorrhiza* inoculation and in combination to each other increased significantly spike per square meter compared to without inoculation treatment in wheat (Patra & Singh, 2019). Subhash-Reddy et al, 2016 reported that Seed inoculation with biofertilizers (*Rhizobium* + Phosphate Solubilizing Microorganisms (PSM)) significantly increased the plant height, nodules per plant, yield attributing characters and yield of groundnut. The application of phosphate-solubilizing bacteria (PSB) in soybean crop revealed that most examined traits were better than chemical fertilizer. Application of 100% RDF + *Azospirillum* + PSB was found to improve the yield and significantly increase the uptake of NPK by safflower (Subhash-Reddy, et al., 2016). *Azotobacter* was able to produce seeds with either significantly higher or similar 1000 seed weight. PSB + VAM + *Azotobacter*, as well as application of sulphur @40 kg ha<sup>-1</sup> may be considered as the best treatment for sunflower, with respect to height, total chlorophyll content, thalamus diameter, weight of thalamus, filled seeds capitulum-1 and 100 seed weight, grain yield, stalk yield, biological yield, harvest index and oil content (Subhash-Reddy, et al.,).

Approximately 170.5 euros per hectare of Sugarcane can be generated when urea is replaced by Biofertilizer (Mendonca, et al., 2018). Singh et al., (2014) found that there was 14% increase in grain yield of paddy crops and 10% increase in straw yield on plant treatment with *cyanobacteria*, also combination of *cyanobacteria* and *Azolla* shows an increase in grain and straw yield and Nitrogen content of the soil.

It has been found from various experimental results that inoculation of *Rhizobium* in different cereal grains increased yield to some extent (Mia & Shamsuddin, 2010).

Mia and Shamsuddin (2010) reported increased Nitrogen uptake by rice plants inoculated with rhizobia. This plant response is significant because of its potential importance to sustainable agriculture, especially in cropping systems involving rotations of rice and legumes.

### ROLE OF BIOFERTILIZER IN POLLUTION CONTROL

Microorganisms impact directly or indirectly in maintaining soil health by their various biological activities. Some microbe like *Azotobacter*, *Pseudomonas*, *Bacillus* and, *Aspergillus* secretes low molecular weight substances capable of mobilizing iron from complex compounds in iron -deficient environments called Siderophores. Although these siderophores are mainly chelating agents for Iron, they are also capable of complexing heavy metals and radionuclides to stable non-toxic forms (Gazso, 2001). Bacteria lower plant stress by secretion of siderophores (Tomer et al., 2016). Singh et al., (2014) reported that some cyanobacterial species degraded pesticides and utilizes it as a source of phosphorus, also remove some herbicides and insecticides and scavenges on various heavy metals like Cd, Cr, Cu, Ni and Zn, etc.

*Rhodococcus* biosurfactant-based biofertilizer has been employed in bioremediation of oil- polluted soil, Plant Growth Promoting Bacteria (PGPB) are also used to upgrade crop yields in addition to solving environmental pollution (Santra, et al., 2015). Santra et al., suggests *Azospirillum* in bioremediation of pesticides polluted soil. Asoegwu et al, (2020) reports cyanobacteria are used in reclamation of alkaline soil.

### CONCLUSION

Biofertilizer have been proven to be the best alternative to chemical fertilizers in addressing the challenge of Agricultural pollution. Biofertilizers are good tools in soil cleansing and enrichment, they aid in plant nutrient uptake, fighting plant pathogens and they show an impressive performance in pollution control. To achieve maximum results plant-microbe interactions have to be well known. Microbial mechanisms of soil bioremediation should be taken into consideration and innovative sustainable



strategies to be designed and implemented to fulfil the current global food demand.

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