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Popular Article

Biofertilizers: A Novel Approach for Sustainable Fruit Production

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Abstract

With an increasing population of 8.03 billion, the world has a significant challenge in achieving Sustainable Development Goal 2 (SDG-2) of zero hunger by supplying the needs, especially in developing nations like India. Even though the green revolution improved food production and made the world and India self-reliable in terms of food security, the excessive use of chemical fertilizers poses a severe hazard to human and environmental health. Biofertilizers, a crucial component of organic farming manages the fertility and condition of the soil. They are environmentally friendly and play a vital role in the production of fruit crops.

Keywords: Biofertilizers, Organic farming, Soil fertility, Fruit production

Introduction

Soil is the basic unit of agriculture with the rhizosphere being the soil's most active zone and as a conduit for a range of biogeochemical processes. Chemical fertilizers are extensively used by farmers to increase crop productivity but, continuous use of these fertilizers may have negative impact on both soil and human health. Therefore, role of organic fertilizers are focused much to maintain soil health. Biofertilizer is one of the most crucial aspects of organic farming as they are comprised of living cells from diverse microorganisms, and have the capability to mobilize inert plant nutrients in soil into available form. They are essentially carrier-based formulations of microorganisms that, when applied to soil, roots, or seeds, increase soil health and improve the availability of nutrients, particularly through their biological activity. The government's ongoing efforts through specific programs like the Paramparagat Krishi Vikas Yojana, Mission Organic Value Chain Development in the North East Region, Capital Investment Subsidy Scheme, National Mission on Oilseeds and Oil Palm, and National Food Security Mission have increased the use of biofertilizers. These programs offer financial assistance to farmers for organic inputs including seeds, biopesticides, biofertilizers, compost/vermicompost, organic manure, botanical extracts etc. (PIB, GOI). Microbial inoculants like nitrogen fixers, phosphorus solubilizes and mobilizers, and plant growth-promoting rhizobacteria are in use for a long time. These biofertilizers are eco-friendly, a source of renewable energy and play a significant role in fruit crop production.

Classification of biofertilizers

Based on nature and function, there are various types of biofertilizers namely:

A. Nitrogen fixing biofertilizers

- Free-living: Do not form any association with plants but live freely and fix atmospheric N2: *Anabaena, Azotobacter, Beijerinkia, Clostridium, Klebsiella, Nostoc,*
- Symbiotic: Associate with plant roots by the formation of root nodules: *Anabaena azollae, Frankia, Rhizobium*
- Associative symbiotic: *Azospirillum*

B. Phosphorus solubilizing biofertilizers

- Bacteria: Bacillus subtilis, B. circulans, B. megaterium var. phosphaticum, Psuedomonas striata,
- Fungi: Aspergillus awamori, Penicillium sp.

C. Phosphorus mobilizing biofertilizers

- Arbuscular mycorrhiza: Acaulospora sp., Gigaspora sp., Glomus sp., Scutellospora sp.,
- Ectomycorrhiza: Amanita sp., Boletus sp., Laccaria sp., Pisolithus sp.
- Ericoid mycorrhiza: Pezizellaericae
- Orchid mycorrhiza: Rhizoctonia solani

D. Plant Growth Promoting Rhizobacteria (PGPR)

- Nitrogen uptake (Azospirillum); Phosphorus uptake (Bacillus, Pseudomonas); Potassium uptake (Bacillus); Iron uptake (Pseudomonas fluorescens) and Sulphur uptake (Thiobacillus)

E. Biofertilizers for micronutrients

- Silicate and Zinc solubilizers: Bacillus sp.

Mode of application

Different methods of biofertilizer applications are as follows:

A. Seed treatment: This the most widely used technique, very effective and economical method of application. The seeds are uniformly coated in a slurry, shade dried, and planted within 24 to 48 hours.

B. Seedling root dipping: Roots of seedlings before transplantation are dipped in a liquid suspension of biofertilizer for a specified period. For fruit crops, the dipping period is typically 20 to 30 minutes and mostly followed in crops like bananas, papaya, strawberries etc.

C. Soil application: It involves addition of biofertilizers directly to the soil or potting mixture. As a result, it improves the ability of soil to survive low moisture levels, reduce direct contact with treated seeds, reduce seed mixing, boost delivery rates, and provide more rhizobia per unit area. Biofertilizers such as Rhizobium (fruit trees or legumes), *Azotobacter* (tea, coffee, coconut), *Glomus*

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mossae, and a*rbuscular mycorrhiza* (grape, litchi, citrus) have been utilised for this purpose (Zahran, 1999)..

Mechanism of biofertilizers

The growth promotion by the bioinoculants can be explained through the following mechanisms:

1. Enhanced availability and absorption of nutrients: Organisms that form an association with roots improve biological nitrogen fixation, solubilization of insoluble phosphates and mobilization of plant nutrients in more quantities.

2. Production of plant growth-promoting hormones: Root colonizing bacteria such as the nitrogen-fixing *Azospirillum* and the phosphorus-solubilizing *Pseudomonas* sp. produce growth hormones (Mia *et al.,* 2005). The higher N fixation and improved root growth have also increased the levels of PGPR, which in turn contributed to greater uptake of water and nutrients. As a result, it led to increased root and shoot growth.

❖ A list of plant growth regulators produced by PGPRs are

Indole-3-acetic acid (*Acetobacter diazotrophicus* and *Herbaspirillum seropedicae*); Gibberellic acid (*Azospirillum lipoferum*)

Zeatin and ethylene (*Azospirillum* sp.) and

Abscisic acid (*Azospirillum brasilense*)

3. Growth suppression of phytopathogenic microorganisms: The introduction of bioinoculants reduced the pathogen density through production of antibiotics and bacteriocins. One such inoculant, *Pseudomonas fluorescens*, has received significant attention due to its antagonistic effect against several plant diseases, including the Banana bunchy top virus, one of the devastating banana viruses (Bora et al., 2016).

Benefits of biofertilizers

The use of biofertilizers has several benefits over inorganic substances for agricultural purposes :

- They can fix 20-200 kg N/ha, release growth promoting substances and eventually improve crop yield by 10-50% (Singh, L. and Sadawart. R. K, 2020).
- N based biofertilizers can provide 25-30% of chemical fertiliser equivalent to N
- PSB biofertilizers can provide 12-20 kg P_2O_5 /ha
- Mycorrhiza provide adequate P and other micronutrients
- Enhance absorption of water by roots
- Mixed formulations have a better impact over individual biofertilizer
- Maintains soil health and keeps soil biologically active without developing resistance to plant pests
- The self-replication of microbes circumvents the need for repeated application.
- The developed bioagents are eco-friendly. They are neither toxic nor cause biomagnification.

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Conclusion

Due to the ongoing usage of chemical fertilizers, soil health is continuously declining, which results in water loss, soil erosion, salinity, weed infestation, etc. The introduction of bioinoculants maintain soil fertility and health as compared to chemical fertilizers. Biofertilizers have enhanced the growth, yield and quality of fruit crops like grape, mango, citrus, papaya, and others. Therefore, using biofertilizers may be the best choice for sustainable fruit production.

Future prospects

To properly utilise the role of biofertilizers in the farmer's field, extension activities including field demonstrations, farmers' fairs, and training activities must be frequently implemented. For farmers to make their biofertilizers profitable, efforts are also necessary for the direction of the development of simple, low-cost technologies.

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