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BIO-PRIMING OF SEEDS: NATURE'S BOOST FOR BETTER CROPS

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ABSTRACT

Bio-priming is an environmentally friendly method of seed treatment that combines the application of helpful microbes and hydration to improve seed germination, plant growth, and stress tolerance in crops. The process improves the vigour of the seedling, inhibits soil-borne diseases, and enhances nutrient intake without the need for chemical input. Bio-priming achieves these using microbial agents like Trichoderma, Bacillus and Pseudomonas to advance sustainable agriculture, particularly among small-scale farmers. Although there are challenges such as strain specificity and low awareness, its environmental and cost benefits make it as a future promising approach.

KEYWORDS: Bio-Priming, Plant growth promoting microbes, Seed treatment, Sustainable agriculture

INTRODUCTION

Sustainable solutions are desperately needed in modern agriculture due to factors like soil deterioration, climate change, and rising food demand. Farming was once transformed by chemical fertilizers and pesticides, but over use of these products has had detrimental effects on the environment, soil health, and pests that are resistant to them. Scientists and farmers are investigating traditional knowledge combined with contemporary research in an effort to find more environmentally friendly options. One such exciting development is bio-priming, a clever, environmentally responsible method that is subtly revolutionizing plant health and seed care.

WHAT IS BIO-PRIMING?

To put it simply, bio-priming is a seed treatment technique that entails coating seeds with advantageous microorganisms, usually fungus, plant growth-promoting rhizobacteria (PGPR), or other bioagents, then moistening them just enough to initiate early metabolic activity. By colonizing the seed surface and the rhizosphere, or emerging root zone, these bacteria aid in the growth and stress resistance of plants. The name comes from the combination of biological coating and hydration (priming).

WHY IS BIO-PRIMING NEEDED?

Numerous problems affect modern agriculture, including:

- Degradation of the soil brought on by excessive cropping and chemical inputs.
- An unpredictable climate that frequently experiences floods and droughts.
- The emergence of diseases and pests that are resistant.
- Small farmers may not always be able to afford the high prices of agrochemicals.

An affordable, environmentally friendly, and sustainable substitute is provided by bio-priming. Frequently without the use of chemicals, it improves seed germination, accelerates growth, and protects against pests and diseases.

HOW DOES BIO-PRIMING WORK?

This is a condensed explanation of the bio-priming procedure:

1. ***Seed Selection:*** Disease-free, high-quality seeds are selected. The key is uniformity.
2. ***Microbial agent selection:*** The crop and the desired advantages (such as drought tolerance, nitrogen fixation, or disease resistance) are taken into consideration when choosing beneficial bacteria like *Trichoderma, Bacillus, Pseudomonas, Azospirillum*, etc.
3. ***Hydration of seeds (Priming):*** To initiate early physiological processes, seeds are soaked in water for a predetermined amount of time.
4. ***Applying microbial inoculants to the surface:*** A slurry containing the chosen microorganisms is then applied to the moistened seeds. Occasionally, a binder such as gum arabic is used.
5. ***Drying and seeding:*** Before being sown, seeds are shade dried.

Once planted, these prepared seeds have stronger roots, grow more quickly, and harbour advantageous microorganisms that improve nutrient absorption and outcompete dangerous pathogens.

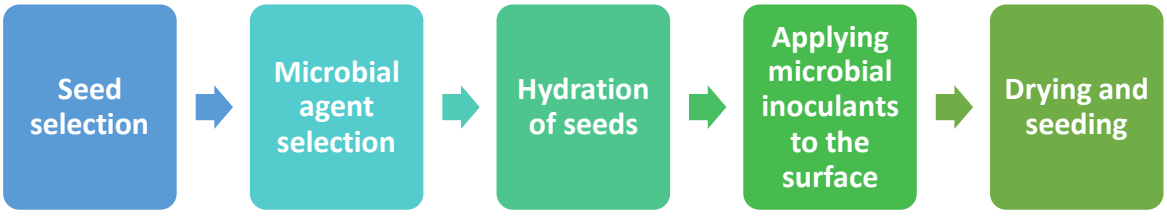

Figure 1. Steps involved in bio-priming of seeds

THE MICROBIAL CHAMPIONS OF BIO-PRIMING

Let's meet some of the microbial stars often used in bio-priming:

1. *Trichoderma spp.*
    - One potent fungus that combats soil-borne illnesses is *Trichoderma spp*.
    - Generates enzymes that break down the cell membranes of pathogens.
    - Boosts plant immunity and growth.
2. *Bacillus subtilis*
    - It is well-known for its biocontrol capabilities.
    - Generates antibiotics and causes plants to develop systemic resistance.
    - Stable endospores are formed, making them ideal for long-term preservation.
3. *Pseudomonas fluorescens*
    - Helps in suppressing root pathogens.
    - Creates siderophores that starve dangerous bacteria by binding iron.
    - Promotes the growth of roots.
4. *Azospirillum* and *Azotobacter*
    - These are free-living nitrogen-fixers.
    - Enhance plant nutrition and soil fertility.
5. *Rhizobium spp*.
    - Rhizobium binds atmospheric nitrogen and creates nodules for legumes.
    - Rhizobium bio-priming guarantees early root colonization.

BENEFITS OF BIO-PRIMING: A GREEN REVOLUTION AT THE SEED LEVEL

The following explains why bio-priming is becoming more popular globally:

1. Enhanced seedling vigour and germination

- Seeds that have been bioprimed germinate more quickly and consistently.
- Auxins and gibberellins, two growth hormones secreted by microbes, promote early growth.
- Bio-primed seeds can lead to better plant establishment and increased plant yield by increasing germination rate, increasing root length and volume, increasing the number of lateral roots (Ait Barka *et al.*, 2006; Chitra and Jijeesh, 2021).

2. Enhanced capacity to handle stress

- Heat stress, salt, and drought can all harm seedlings.

- Beneficial microorganisms enhance osmotic equilibrium and root architecture, which helps plants in withstanding stress.
- Application of *Pseudomonas geniculate* reduced the sodium uptake and increased the uptake of potassium and calcium in the roots of maize showing its role in controlling the ionic balance/homeostasis in the roots of maize under high salt stresses (Singh *et al.*, 2020).

3. Natural protection against illnesses

- By combating soilborne infections, microorganisms such as *Trichoderma* and *Pseudomonas* lessen the need for fungicides.
- Bio-priming of *Pennisetum glaucum* seeds with *Pseudomonas* spp. strains helped to enhance the plant growth and resistance to the disease (Raj *et al.*, 2004)

4. Improved absorption of nutrients

- Iron, phosphorus, and other nutrients are mobilized by microbes, increasing their availability to plants.

6. Economical and farmer-friendly

- Bio-priming does not require expensive equipment and is inexpensive, making it ideal for marginal and small farmers.

6. Sustainable and eco-friendly

- No chemical spills and traces.
- It is the nature assisting the mother nature.

LIMITATIONS AND CHALLENGES

Despite being a promising method, bio-priming has certain drawbacks,

- Bioagents may have a short shelf life if they are not stored properly.
- Not all microorganisms are compatible with all crops or soils due to strain-specific effects.
- For many crops, there is a lack of standardization protocols.
- In certain areas, farmer awareness and training are still lacking.

CONCLUSION

Despite its modest appearance, bio-priming has the ability to completely transform the way we produce food. Seeds are given a natural armour and a strong push toward healthy, sustainable growth by fusing cutting-edge research with traditional biological knowledge. It is a low-risk, high-reward intervention for small holding farmers, and a frontier of exciting discoveries for researchers.

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