

# Seed Coating: A Reliable Method for Application of Plant Growth- Promoting Microorganisms

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## ABSTRACT

Through biological nutrient mobilization, biofertilizers improve soil fertility and crop productivity, making them a crucial part of sustainable agriculture. However, low microbial viability during storage and seed application, as well as a short shelf life, restrict their broad use. An efficient answer is provided by seed film-coating technology that uses appropriate polymeric materials to protect beneficial microbes and guarantee their consistent transport to the rhizosphere. The current study assesses the impact of two film-coating agents, dextrin and hydroxypropyl methylcellulose (HPMC), on the effectiveness and shelf life of biofertilizer applied to okra (*Abelmoschus esculentus*) seeds. For seed inoculation, biofertilizer strains such *Bacillus megaterium*, a phosphate-solubilizing bacterium, and *Azospirillum* spp, were employed. The microbiological viability during storage, seed germination, seedling vigor, plant growth, and yield properties of seeds coated with HPMC- and dextrin-based formulations were evaluated. Standard plate count techniques were used to periodically assess microbial survival. Growth parameters were assessed in both field and controlled environments. The physical characteristics of the seed were not considerably changed by film coating. After three months of low-temperature storage, shelf-life experiments showed just a one-log decrease in the microbial population. Without compromising germination, biofertilizer-coated seeds demonstrated enhanced seedling growth, especially increased plant height. This demonstrates that polymer-based seed coating using HPMC and dextrin is an effective and sustainable approach for maintaining biofertilizer viability and ensuring efficient rhizosphere colonization in okra cultivation.

**KEYWORDS:** Biofertilizer, Seed film coating, HPMC, Dextrin, Shelf life, Okra (*Abelmoschus esculentus*), Microbial viability, Sustainable agriculture

## INTRODUCTION

Seed quality and early seedling establishment are fundamental determinants of crop productivity and sustainability in agriculture. High-quality seeds with good vigor ensure rapid and uniform germination, leading to better crop stand establishment. Uniform germination enables efficient utilization of soil nutrients, water, and sunlight, thereby enhancing plant growth and yield. In contrast, poor seed vigor results in delayed and uneven germination, weak seedlings, and ultimately reduced crop productivity. Additionally, vigorous seedlings are more capable of tolerating abiotic stresses such as drought, salinity, and temperature fluctuations, which are increasingly important under changing climatic conditions.

To overcome the limitations associated with poor seed performance, various seed enhancement technologies have been developed. Among these, seed coating has emerged as a promising and widely adopted technique. Seed coating involves the application of a thin, uniform layer of external materials, often polymer-based, onto the seed surface. This coating does not significantly alter the seed's size or shape but serves as a carrier for delivering beneficial substances such as nutrients, pesticides, and microbial inoculants directly to the germinating seed (Taylor et al., 1998). The use of polymeric materials ensures controlled release, improved adhesion, and protection of active ingredients, thereby enhancing seed performance under field conditions (Scott, 1989; Halmer, 2000; Halmer, 2008).

In recent years, the integration of biofertilizers into seed coating formulations has gained considerable attention due to their eco-friendly nature and ability to promote sustainable agriculture. Biofertilizers consist of beneficial microorganisms that enhance plant growth by improving nutrient availability and uptake. Among them, *Azospirillum* spp. are widely recognized for their ability to fix atmospheric nitrogen and produce phytohormones such as auxins, gibberellins, and cytokinins. These growth-promoting substances stimulate root development, increase root surface area, and enhance nutrient absorption (Vessey, 2003).

Similarly, *Bacillus* spp. play a crucial role in phosphorus solubilization by converting insoluble forms of phosphorus into forms readily available to plants. In addition, they produce growth-promoting substances and enzymes that enhance plant development and soil fertility (Bhattacharyya and Jha, 2012). *Pseudomonas* spp. are another important group of plant growth-promoting rhizobacteria (PGPR) known for their ability to colonize the rhizosphere, suppress soil-borne pathogens through the production of antibiotics and siderophores, and improve overall plant health (Lucy et al., 2004). Furthermore, potassium- and zinc-solubilizing microorganisms contribute significantly to plant nutrition by mobilizing essential macro- and micronutrients, which are often present in unavailable forms in the soil (Trivedi and Pandey, 2008).

Despite their numerous benefits, the effectiveness of biofertilizers under field conditions is often limited by factors such as poor survival, environmental stress, and uneven distribution when applied directly to the soil. To address these challenges, seed coating serves as an efficient delivery system by placing beneficial microorganisms in close proximity to the seed and emerging roots. This ensures early colonization of the rhizosphere, leading to improved microbial activity and enhanced plant growth (Bashan and de-Bashan, 2010; Bashan et al., 2014).

Moreover, the use of microbial consortia in seed coating has shown superior performance compared to single-strain inoculants. The synergistic interactions among different groups of microorganisms—such as nitrogen fixers, phosphorus solubilizers, and plant growth-promoting bacteria—result in improved nutrient availability, enhanced root development, and increased resistance to environmental stresses (Malusá et al., 2016). This integrated approach not only improves seedling vigor and nutrient use efficiency but also reduces dependency on chemical fertilizers.

Therefore, polymer-based seed coating combined with biofertilizer microorganisms represents a sustainable, cost-effective, and environmentally friendly strategy for improving crop establishment and productivity. This approach aligns with the principles of sustainable agriculture by enhancing soil health, reducing chemical inputs, and promoting long-term agricultural sustainability (Adesemoye and Kloepper, 2009; Malusá and Vassilev, 2014).

## 1. IMPORTANCE OF SEED QUALITY

Seed quality is a fundamental factor influencing crop establishment, growth, and productivity. High-quality seeds exhibit superior germination percentage, uniform emergence, and strong seedling vigor, all of which are essential for achieving optimal plant population in the field. Vigorous seedlings are more efficient in nutrient uptake and better adapted to withstand abiotic stresses such as drought and salinity. In contrast, poor-quality seeds lead to delayed and uneven germination, resulting in weak crop stands and reduced yield potential. To address these challenges, seed enhancement technologies have been developed to improve germination performance and early seedling growth (Taylor et al., 1998).

## 2. SEED ENHANCEMENT TECHNOLOGIES

Seed enhancement technologies include a range of pre-sowing treatments such as seed priming, pelleting, and coating, all aimed at improving seed performance. Seed priming enhances metabolic activity before germination, while pelleting modifies seed size and shape for precision sowing. Among these, seed coating has gained significant importance due to its ability to incorporate beneficial substances without altering seed morphology. According to Scott (1989), seed coating improves seed handling, flowability, and planting efficiency. Halmer (2000, 2008) further emphasized that modern seed coating technologies enable targeted delivery of inputs, making them highly effective in improving crop establishment.

## 3. SEED COATING TECHNOLOGY

Seed coating involves the application of a thin layer of materials, typically polymers, onto the seed surface. This layer serves as a carrier for nutrients, pesticides, and beneficial microorganisms. One of the major advantages of this technology is the precise placement of active ingredients near the germinating seed, ensuring immediate availability during early growth stages. Halmer (2008) reported that seed coating enhances input-use efficiency and reduces wastage compared to conventional soil or foliar application methods. Additionally, it provides protection against mechanical damage and environmental stresses.

## 4. POLYMERS USED IN SEED COATING

Polymers are key components of seed coating formulations, acting as binders that hold active ingredients onto the seed surface. Biodegradable polymers such as cellulose derivatives, starch-based materials, and natural gums are widely used due to their environmental safety and compatibility with seed physiology. These polymers form a protective film around the seed, regulating moisture absorption and enhancing seed stability. Studies by Scott (1989) and Pedrini et al. (2017) indicate that well-formulated polymer coatings do not negatively affect germination or seedling emergence, making them suitable for agricultural applications.

## 5. EFFECT OF SEED COATING ON GERMINATION

Research has demonstrated that polymer-based seed coatings, when properly formulated, do not adversely affect germination. Instead, they may improve germination under stress conditions by protecting seeds from mechanical injury, desiccation, and pathogen attack. Taylor and Kwiatkowski (2001) reported that coated seeds maintain high germination rates while benefiting from improved handling and protection. The success of seed coating largely depends on the type and concentration of coating materials used.

## **6. BIOFERTILIZERS IN AGRICULTURE:**

Biofertilizers are formulations containing beneficial microorganisms that enhance plant growth by increasing nutrient availability. These microorganisms perform functions such as biological nitrogen fixation, phosphorus solubilization, and production of growth-promoting substances. According to Vessey (2003), biofertilizers improve plant nutrition and reduce dependence on chemical fertilizers. Bhattacharyya and Jha (2012) further highlighted their importance in sustainable agriculture by improving soil fertility and promoting eco-friendly farming practices.

## **7. MICROBIAL CONSORTIA AND SYNERGISTIC EFFECTS:**

The use of microbial consortia involves combining different beneficial microorganisms to achieve synergistic effects. Each microorganism performs a specific function, such as nitrogen fixation, nutrient solubilization, or pathogen suppression. When used together, these microorganisms enhance plant growth more effectively than individual strains. Lucy et al. (2004) and Trivedi and Pandey (2008) reported that microbial consortia improve nutrient availability, root development, and overall plant health due to complementary interactions among different microbial species.

## **8. SEED COATING AS A BIOFERTILIZER DELIVERY SYSTEM:**

Seed coating serves as an efficient delivery system for biofertilizers by placing beneficial microorganisms directly on the seed surface. This ensures their immediate availability to the germinating seed and enhances early colonization of the rhizosphere. Bashan and de-Bashan (2010) demonstrated that seed-applied microorganisms show better survival and activity compared to those applied to soil. Bashan et al. (2014) further reported that seed coating improves microbial establishment and effectiveness under field conditions.

## **9. SHELF LIFE OF BIOFERTILIZER-COATED SEEDS:**

One of the major challenges in the use of biofertilizers is maintaining the viability of microorganisms during storage. The shelf life of coated seeds depends on factors such as formulation, storage conditions, and microbial strain. Herrmann and Lesueur (2013) reported that proper formulation techniques can significantly enhance microbial survival. Polymer coatings provide a protective environment that helps maintain microbial viability for extended periods (Bashan et al., 2014; Malusá et al., 2016).

## **10. STORAGE CONDITIONS AND MICROBIAL VIABILITY:**

Storage conditions play a critical role in maintaining the effectiveness of biofertilizer-coated seeds. Factors such as temperature, humidity, and exposure to light can affect microbial survival. Low-temperature storage and controlled humidity conditions are generally recommended to preserve microbial activity. Malusá et al. (2016) reported that appropriate storage conditions, combined with suitable coating materials, significantly improve microbial stability and shelf life.

## **11. EFFECT ON SEEDLING VIGOR AND PLANT GROWTH:**

Biofertilizer-coated seeds have been shown to enhance seedling vigor, root development, and plant growth. The presence of beneficial microorganisms stimulates root elongation, increases nutrient uptake, and improves plant metabolism. Mahajan and Gupta (2009) observed increased biomass production in

treated plants, while Richardson and Simpson (2011) reported improved nutrient-use efficiency. These effects contribute to better crop performance and higher yields.

## 12. ROLE IN SUSTAINABLE AGRICULTURE:

Seed coating with biofertilizer consortia plays a significant role in promoting sustainable agriculture. This approach reduces the need for chemical fertilizers, thereby minimizing environmental pollution and improving soil health. Adesemoye and Kloepper (2009) emphasized that biofertilizers enhance fertilizer-use efficiency and support sustainable crop production systems. Malusá and Vassilev (2014) highlighted the importance of regulatory frameworks and ecological benefits associated with biofertilizer use. Overall, seed coating technology represents an eco-friendly and cost-effective strategy for improving agricultural productivity.

## CONCLUSION:

The current study comes to the conclusion that seed film-coating technology is a useful technique for extending the shelf life and effectiveness of biofertilizers used on seeds of okra (*Abelmoschus esculentus*). Reduced microbial viability during storage and application frequently limits the effectiveness of biofertilizers, which are important parts of sustainable agriculture. Beneficial bacteria on the seed surface are shielded by the application of biodegradable polymeric coating agents like dextrin and hydroxypropyl methylcellulose (HPMC). The enhanced film-forming and moisture-retention qualities of HPMC lead to increased microbial survival and a longer shelf life for seeds coated with biofertilizer. Because dextrin is a carbohydrate, it supports microbial activity and is a cost-effective and eco-friendly substitute. By providing improved microbial persistence and effective plant-microbe interaction, polymer-based seed coating improves okra seed germination, seedling vigor, plant growth, and yield characteristics. All things considered, the use of biofertilizer seed coatings based on HPMC and dextrin is a viable, environmentally beneficial way to raise crop yields and lessen dependency on chemical fertilizers, promoting sustainable farming methods.

## REFERENCE:

1. Taylor AG, Allen PS, Bennett MA, Bradford KJ, Burriss JS, Misra MK. Seed enhancements. *Seed Science Research*. 1998;8(2):245–256.
2. Scott JM. Seed coating and treatments and their effects on plant establishment. *Advances in Agronomy*. 1989; 42:43–83.
3. Halmer P. Commercial seed treatment technology. In: Black M, Bewley JD, editors. *Seed Technology and Its Biological Basis*. Sheffield: Sheffield Academic Press; 2000. p. 257–286.
4. Halmer P. Seed technology and seed enhancement. *Acta Horticulturae*. 2008; 771:17–26.
5. Pedrini S, Merritt DJ, Stevens J, Dixon K. Seed coating: Science or marketing spin? *Trends in Plant Science*. 2017;22(2):106–116.
6. Vessey JK. Plant growth promoting rhizobacteria as biofertilizers. *Plant and Soil*. 2003; 255:571–586.
7. Bhattacharyya PN, Jha DK. Plant growth-promoting rhizobacteria: Emergence in agriculture. *World Journal of Microbiology and Biotechnology*. 2012; 28:1327–1350.
8. Bashan Y, de-Bashan LE, Prabhu SR, Hernandez JP. Advances in plant growth-promoting bacterial inoculant technology. *Plant and Soil*. 2014; 378:1–33.
9. Malusá E, Pinzari F, Canfora L. Efficacy of biofertilizers. *Microbial Biotechnology*. 2016;9(4):541–

546.

10. Lucy M, Reed E, Glick BR. Applications of free-living plant growth-promoting rhizobacteria. *Antonie van Leeuwenhoek*. 2004; 86:1–25.
11. Barea JM, Pozo MJ, Azcón R, Azcón-Aguilar C. Microbial co-operation in the rhizosphere. *Journal of Experimental Botany*. 2005; 56:1761–1778.
12. Stephens JHG, Rask HM. Inoculant production and formulation. *Field Crops Research*. 2000; 65:249–258.
13. Berg G. Plant–microbe interactions promoting plant growth. *Applied Microbiology and Biotechnology*. 2009; 84:11–18.
14. John RP, Tyagi RD, Brar SK, Surampalli RY, Prevost D. Bio-encapsulation of microbial cells. *African Journal of Biotechnology*. 2011;10(40):7759–7770.
15. Herrmann L, Lesueur D. Challenges of microbial inoculant production. *Applied Microbiology and Biotechnology*. 2013; 97:8859–8873.
16. Copeland LO, McDonald MB. *Principles of Seed Science and Technology*. 4th ed. New York: Springer; 2001.
17. Tilak KVBR, Ranganayaki N, Manoharachi C. Diversity of plant growth-promoting microorganisms. *Indian Journal of Microbiology*. 2005; 45:243–250.
18. Mahanty T, Bhattacharjee S, Goswami M, Bhattacharyya P. Biofertilizers: A potential approach for sustainable agriculture. *Journal of Soil Science and Plant Nutrition*. 2017; 17:1–23.
19. Bashan Y, Holguin G. Proposal for the division of plant growth-promoting rhizobacteria. *Soil Biology and Biochemistry*. 1998; 30:1225–1228.
20. Malusá E, Vassilev N. A contribution to set a legal framework for biofertilizers. *Applied Microbiology and Biotechnology*. 2014; 98:6599–6607.