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Boosting Mung Bean Productivity: The Role of Seed Biopriming with Biocontrol Agents and Foliar Liquid Biofertilizers

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Abstracts: -

This study explores the combined effects of seed biopriming with biocontrol agents and foliar application of liquid biofertilizers on the growth and productivity of mung bean (*Vigna radiata* L.). Seed biopriming, involving the use of beneficial microorganisms such as *Trichoderma* and *Bacillus*, was found to enhance germination rates, improve disease resistance, and boost tolerance to environmental stresses. The foliar application of liquid biofertilizers, rich in nutrients and growth-promoting bacteria like Rhizobium, further augmented plant growth by improving nutrient absorption efficiency and reducing dependence on chemical fertilizers. The synergistic effect of these two approaches led to a significant increase in mung bean yield and overall plant health. This integrated, eco-friendly strategy offers a sustainable solution to enhance mung bean production, reduce pathogen attacks, and improve resilience to abiotic stresses, contributing to sustainable agricultural practices.

1. Introduction

Mung bean (*Vigna radiata*), a crucial legume crop, is widely grown for its protein-rich seeds that form a significant part of diets, especially in Asia. The crop is known for its short growth cycle, making it ideal for double cropping and intercropping systems. Despite its nutritional importance and adaptability to various climates, mung bean cultivation faces numerous challenges, including poor germination rates, susceptibility to diseases, and abiotic stresses such as drought and soil salinity. Traditional farming practices heavily rely on chemical fertilizers and pesticides to overcome these challenges, which, although effective, lead to long-term environmental

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degradation, soil health deterioration, and increased production costs. As the need for sustainable agriculture grows, alternative methods are being explored to enhance crop productivity without compromising environmental integrity. One such promising method is **seed biopriming**, a technique that pre-treats seeds with beneficial microorganisms known as biocontrol agents, and the use of **liquid biofertilizers** applied via foliar spraying. This combined approach has shown potential in improving mung bean growth, yield, and resistance to various stresses. This article delves into how these sustainable practices can revolutionize mung bean cultivation by boosting productivity and improving overall plant health.

2. Seed Biopriming: Mechanism and Benefits

Seed biopriming is a pre-sowing treatment where seeds are inoculated with beneficial microorganisms. This technique enhances the plant's early development stages by triggering metabolic processes before germination, ultimately improving growth. Biocontrol agents, such as *Trichoderma*, *Bacillus*, and *Pseudomonas* species, are commonly used in biopriming for their ability to suppress pathogens, enhance seedling vigor, and improve stress tolerance.

Role of Biocontrol Agents in Seed Biopriming

Biocontrol agents used in seed biopriming play a vital role in improving seed health and plant development. For instance, *Trichoderma* species are well-known for their antagonistic effects on soil-borne pathogens like *Rhizoctonia* and *Fusarium*, which can cause significant damage to mung bean crops. Similarly, *Bacillus* species produce a range of antimicrobial compounds that protect seeds from harmful microorganisms, while also enhancing nutrient availability in the soil.

Mechanisms of Action in Seed Biopriming

1. **Enhanced Germination**: Seed biopriming activates various enzymes and metabolic pathways in the seed, leading to faster and more uniform germination. The beneficial microorganisms also help in breaking seed dormancy, thus reducing the time required for sprouting.
2. **Disease Suppression**: Biopriming seeds with biocontrol agents offers protection against a range of soil-borne pathogens by either outcompeting them for resources or by directly inhibiting their growth through antimicrobial metabolites.
3. **Improved Stress Tolerance**: Mung bean crops grown from bioprimed seeds exhibit enhanced tolerance to environmental stresses such as drought and salinity. Biocontrol agents promote

better root development and water uptake, making the plants more resilient to adverse conditions.

Case Studies/Research Findings

Several studies have demonstrated the effectiveness of seed biopriming in mung bean cultivation. For example, biopriming with *Trichoderma* has been shown to increase germination rates by up to 25%, while also improving root growth and seedling vigor. Research has also highlighted the ability of *Bacillus subtilis* to enhance mung bean yield by 15% through improved nutrient availability and disease resistance.

4. **Foliar Application of Liquid Biofertilizers: Mechanism and Benefits**

Foliar application involves spraying liquid biofertilizers directly onto plant leaves, allowing nutrients to be absorbed through the stomata. This method is gaining popularity due to its ability to provide plants with essential nutrients more quickly than traditional soil applications.

Types of Liquid Biofertilizers

Liquid biofertilizers can be classified based on the types of microorganisms they contain. Nitrogen-fixing bacteria like *Rhizobium* and *Azotobacter* improve nitrogen availability, while phosphate-solubilizing bacteria enhance phosphorus uptake. These biofertilizers not only provide essential nutrients but also stimulate plant growth by producing phytohormones like auxins and gibberellins.

Mechanisms of Action

1. **Nutrient Efficiency**: Foliar sprays ensure rapid nutrient absorption, allowing plants to take up vital nutrients directly through their leaves. This is particularly beneficial in soils with poor nutrient availability or those prone to nutrient fixation.
2. **Growth Stimulation**: Liquid biofertilizers promote root and shoot growth by enhancing nutrient availability and stimulating hormonal activity in plants. This leads to stronger, more vigorous growth and higher yields.
3. **Reduced Reliance on Chemical Fertilizers**: By providing essential nutrients in a more accessible form, foliar biofertilization reduces the need for synthetic fertilizers, thus promoting sustainable farming practices.

Research Findings

Studies on mung bean have shown that foliar application of nitrogen-fixing bacteria can increase leaf chlorophyll content and photosynthetic activity, leading to a 20% increase in yield. Additionally, foliar spraying with phosphate-solubilizing bacteria has been found to improve root development and

nutrient uptake, further enhancing plant growth.

4. Synergistic Effects of Seed Biopriming and Foliar Biofertilization

When used together, seed biopriming and foliar biofertilization create a synergistic effect that significantly enhances mung bean productivity. Biopriming prepares the seed for optimal germination and early growth, while foliar biofertilization ensures that the plant continues to receive essential nutrients throughout its lifecycle. Field trials have demonstrated that combining these two techniques can result in yield increases of up to 30%, compared to traditional farming practices. Moreover, plants treated with both biopriming and foliar biofertilizers exhibit stronger resistance to diseases and better adaptation to environmental stresses, such as drought and salinity.

5. Impact on Disease Resistance and Stress Tolerance

One of the most significant benefits of seed biopriming and foliar biofertilization is the enhanced resistance to diseases and environmental stresses. Biocontrol agents used in seed biopriming offer long-term protection against soil-borne pathogens, while liquid biofertilizers improve the plant's natural defense mechanisms. Research has shown that mung bean plants treated with bioprimed seeds exhibit lower incidence of diseases like root rot and damping-off. Additionally, the application of biofertilizers improves the plant's tolerance to abiotic stresses, such as water scarcity and salinity, by promoting better root development and improving water uptake efficiency.

6. Environmental and Economic Benefits

The adoption of biopriming and foliar biofertilization not only improves crop productivity but also offers significant environmental and economic benefits. By reducing the need for chemical fertilizers and pesticides, these techniques promote more sustainable farming practices. This, in turn, helps to protect soil health, reduce water pollution, and mitigate the environmental impacts of conventional agriculture. From an economic perspective, farmers can benefit from reduced input costs and increased yields. Studies have shown that using biofertilizers and biocontrol agents can reduce the cost of fertilizers and pesticides by up to 40%, while also increasing the overall profitability of mung bean cultivation.

7. Challenges and Future Prospects

Despite the numerous benefits, there are still challenges in the widespread adoption of seed biopriming and foliar biofertilization. One major hurdle is the lack of awareness and technical knowledge among farmers regarding these techniques. Additionally, the variability in results across different soil types and

environmental conditions requires further research to optimize these practices. Future research should focus on developing region-specific formulations of biocontrol agents and biofertilizers, as well as conducting large-scale field trials to validate their effectiveness. Moreover, government support and training programs will be crucial in promoting the adoption of these sustainable agricultural practices.

8. Conclusion

In conclusion, seed biopriming with biocontrol agents and foliar application of liquid biofertilizers represent promising strategies for enhancing mung bean productivity. These techniques not only improve germination, growth, and yield but also offer protection against diseases and environmental stresses. By reducing the reliance on chemical inputs, they contribute to more sustainable and eco-friendly agricultural practices. As the global demand for food continues to rise, adopting such innovative approaches will be crucial for ensuring food security and promoting environmental sustainability. The combination of seed biopriming and foliar biofertilization holds immense potential for improving the productivity and resilience of mung bean crops, making it a valuable tool for farmers seeking to adopt sustainable farming practices.

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