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Bio-priming of Sugarcane Setts and Nodes: A Novel Technology for Enhancing Sugarcane Yield

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Introduction:

Sugarcane is a critical cash crop, particularly in tropical and subtropical regions, contributing significantly to the global supply of sugar and bioethanol. However, increasing the yield of sugarcane is a constant challenge for farmers and researchers due to various biotic and abiotic stresses (Kumar *et al.*, 2024a). Bio-priming, a novel technique that integrates biological and sugarcane setts or nodes treatment methods, has emerged as a promising solution to enhance the productivity and health of sugarcane crops (Sinha *et al.*, 2024). This article explores the concept, methods, benefits and potential of bio-priming sugarcane setts and nodes.

Bio-priming

Bio-priming involves the use of beneficial microorganisms to treat sugarcane setts or nodes or plant propagules before planting. This technique combines the advantages of sugarcane setts or nodes or plant propagules priming and biological control, promoting seed germination (Kumar *et al.*, 2024b), enhancing disease resistance (Minnatullah *et al.*, 2023; Sinha *et al.*, 2023), and improving overall plant vigour. In sugarcane cultivation, bio-priming can be applied to setts (stem cuttings) and nodes, the primary planting materials.

Beneficial microorganisms such as bacteria, fungi, or bioactive compounds like plant growth-promoting substances are selected based on their ability to improve plant growth, nutrient uptake and resistance to pests and diseases.

Methods of Bio-priming Sugarcane Setts and Nodes

1. **Selection of Beneficial Microorganisms:**
   - *Rhizobacteria*: These root-associated bacteria enhance nutrient uptake and protect against soil pathogens (De *et al.*, 2006).
   - *N Fixier*: The utilization of a novel bio-

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inoculants containing *Acetobacter*, *Pseudomonas fluorescens*, *Azospirillum brasilense*, and *Bacillus subtilis* and possessing the technology to facilitate the entry of bacteria through the stomata, and help in nitrogen fixation in sugarcane crop (Kumar et al.,2023; Kumar et al., 2024c)

- *Phosphate Solubilizer*: Phosphate-solubilizing microorganisms (PSMs) are a group of bacteria and fungi that can help plants absorb phosphorus from soil. They can convert insoluble phosphorus into a form that plants can use. PSMs can also help plants tolerate stress and improve crop yields (Kumar et al., 2024d)
- *Potassium Solubilizer*: Potassium solubilizers are microorganisms that convert insoluble potassium into forms that plants can absorb. Potassium is a key nutrient for plant growth and development. Potassium solubilizers include bacteria and fungi that produce organic acids to release potassium from minerals.
- It is known that potassium solubilizing bacteria (KSB) can solubilize K-bearing minerals and convert the insoluble K to soluble forms of K available to plant uptake. Many bacteria such as *Acidothiobacillus ferrooxidans*, *Paenibacillus* spp., *Bacillus mucilaginosus* and *B. edaphicus* are very effective (Kumar et al., 2024e)
- *Sulphur Solubilizing Bacteria*: Sulphur solubilizing bacteria (SSB) are microorganisms that improve the availability of sulphur in soil, which helps plants absorb more sulphur. This can lead to a number of benefits, including; Increased crop yield, Improved plant health, Improved chlorophyll formation, Improved plant winter hardiness, Improved use of other nutrients, Increased fruiting, Improved oil content and pungency of oil-bearing crops and ultimately reduced need for sulphur fertilizer (Kumar et al., 2024f)
- *Mycorrhizal* Fungi: These fungi form symbiotic relationships with roots, aiding in nutrient and water absorption (Kumar and Maurya., 2006). There are several ways through which mycorrhizal fungi benefit plants and the soil like, *increase nutrient uptake*: Mycorrhizal fungi help plants absorb nutrients like phosphates, nitrates, and zinc; *Improve soil structure*: Mycorrhizal fungi produce a sticky protein called glomalin that glues soil

particles together, which helps the soil retain water and nutrients; *Protect against disease*: Mycorrhizal fungi can help protect plants from soil-borne diseases; *increase tolerance to adverse conditions*: Mycorrhizal fungi can help plants to tolerate adverse conditions;

- *Trichoderma* spp.: Trichoderma spp. significantly suppresses the growth of plant pathogenic microorganisms and regulates the rate of plant growth, it is well known for their antagonistic properties against various plant pathogens. Roots of *Trichoderma*-treated plants have also exhibited a higher ability to explore the soil and an improved uptake of minerals (Maurya and Kumar., 2006).

2. **Preparation of Microbial Inoculants:**
   - Culturing beneficial microorganisms in nutrient media.
   - Formulating the inoculant as a liquid suspension or powder.
3. **Preparation of Bio-Priming Solution**:
   - The selected bioagents or bioactive compounds are formulated into a solution suitable for coating or soaking the sugarcane setts or nodes or plant propagules. This solution may contain nutrients or substrates to support the growth and survival of the bioagents. (Kumar *et al*., 2014)
4. **Application Process/ Treatment of Setts:**
   - Sugarcane setts or nodes are then immersed, sprayed, or coated with the bio-priming solution for a specific duration.
   - The setts and nodes are thoroughly coated to ensure proper adherence of the bio-agents to the surface of plant tissues. Air-drying the treated setts and nodes before planting (Kumar and Paswan 2015).
5. **Incubation Period**:
   - After treatment, the setts or nodes are allowed to incubate for a specific period under controlled conditions. This allows the bio-agents to colonize the surface of the sugarcane setts or nodes or plant propagules and establish beneficial interactions with the plant tissues (Kumar et al., 2018).
6. **Planting in the Field**:
   - Once the incubation period is complete, the treated sugarcane setts or nodes or plant propagules are planted in the field according to standard planting practices. The bio-primed setts are placed in the soil and the sugarcane crop is managed throughout its growth cycle

Benefits of Bio-priming in Sugarcane Cultivation

1. **Enhanced Germination and Root Development:**
   - ❖ The beneficial microorganisms or bioactive compounds stimulate root development, nutrient uptake, and overall plant growth, leading to increased biomass and yield (Kumar *et al*., 2023)
   - ❖ Bio-primed setts or nodes exhibit faster and more uniform germination.
   - ❖ Improved root architecture leads to better nutrient and water uptake.
2. **Disease Resistance:**
   - ❖ Beneficial microbes produce antimicrobial compounds that suppress soil-borne pathogens.
   - ❖ Induced systemic resistance in plants provides long-lasting protection against diseases.
3. **Stress Tolerance:**
   - ❖ Bio-primed sugarcane plants exhibit enhanced tolerance to environmental stresses (abiotic stresses) such as drought, salinity and disease pressure, resulting in improved resilience and productivity
   - ❖ Enhanced antioxidant activity in plants helps mitigate the effects of environmental stress.
4. **Improved Yield and Quality:**
   - ❖ Higher tiller count and biomass production.
   - ❖ Increased sugar content and improved juice quality.
5. **Reduced Dependency on Chemical Inputs**:
   - ❖ By promoting natural mechanisms for plant growth and protection, bio-priming technology can reduce the reliance on synthetic fertilizers and pesticides, making sugarcane cultivation more sustainable and environmentally friendly.
6. **Cost-Effective**:
   - ❖ While initial investment may be required for developing and applying bio-priming solutions, the long-term benefits in terms of increased yield and reduced input costs can outweigh the initial investment.

Case Studies and Research Findings

- ❖ Several studies have demonstrated the effectiveness of bio-priming in sugarcane cultivation. For instance:
- ❖ A study conducted by the Sugarcane Research Institute, RPCAU, Pusa showed that bio-priming with *Acetobacter*, *Azospirillum brasilense*, PSB and *Trichoderma harzianum* significantly increased germination rates and yield.
- ❖ Field trials in Brazil reported that bio-priming with mycorrhizal fungi improved nutrient uptake, leading to

higher biomass and sugar content in sugarcane.

Challenges and Future Prospects

- While bio-priming presents numerous benefits, its widespread adoption faces several challenges:
- Standardization of protocols for different regions and varieties.
- Ensuring the availability and quality of microbial inoculants.
- Training farmers and extension workers in bio-priming techniques.

Future research focus:

- Future research should focus on the following aspects
- Developing multi-strain microbial consortia for broader spectrum benefits.
- Understanding the molecular mechanisms underlying plant-microbe interactions.
- Integrating bio-priming with other sustainable agricultural practices.

Conclusion

Bio-priming of sugarcane setts and nodes represents a promising technology for enhancing sugarcane yield and resilience. By harnessing the power of beneficial microorganisms, this innovative approach can contribute to sustainable agriculture, ensuring higher productivity and better quality crops. Continued research and development, along with farmer education and support, are essential for the successful implementation and scaling of bio-priming in sugarcane cultivation. Overall, sugarcane setts bio-priming technology holds promise for improving the productivity and sustainability of sugarcane cultivation, contributing to the economic viability of sugarcane farming while minimizing its environmental impact.

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