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Tissue-Cultured Banana Plantlets' Field Performance and Cultivation Methods: A Comparison with Traditionally Propagated Planting Materials

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ABSTRACT

One of the most important fruit crops in the world, bananas (Musa spp.) are essential to tropical and subtropical regions' food security, rural employment, and revenue generation. The development of tissue culture (TC) propagation has revolutionised banana production by enabling the mass-scale generation of robust, disease-free, and genetically stable plantlets. However, achieving optimal results requires an integrated and methodical approach that balances soil health, water management, fertiliser application, and pest control. Laboratory excellence alone does not guarantee superior field performance. To enhance yield, fruit quality, and profitability, this study — 'From Lab to Field: Integrated Cultivation Practices for Maximising Banana Yield' — provides a comprehensive framework linking laboratory efficiency with field success.

INTRODUCTION

Banana (Musa spp.) ranks among the top globally cultivated fruit crops, serving as a vital source of nutrition, livelihood, and economic stability for millions of farmers in tropical and subtropical regions. India stands as one of the largest producers, contributing over 25% to the global banana output. Despite the adoption of tissue culture (TC) technology for large-scale propagation, many growers continue to face challenges in translating laboratory potential into consistent field performance.

While tissue-cultured plantlets offer disease-free and uniform growth advantages, field-level factors such as soil fertility, water availability, pest management, and nutrient balance ultimately determine the success of banana cultivation. Therefore, a well-integrated system that combines scientific cultivation methods, eco-friendly pest management, and resource-efficient technologies is necessary to maximise yield and ensure sustainability.

Importance of Tissue Culture in Banana Propagation

Tissue culture technology has significantly advanced banana production by ensuring uniform and rapid multiplication of elite cultivars, disease-free and genetically stable planting material, early maturity, and better crop synchronization. However, many farmers experience yield variability due to improper acclimatisation, suboptimal soil conditions, or inadequate field care. The real success of TC propagation lies in a carefully managed transition from the laboratory to the field, where scientific cultivation practices uphold the genetic and physiological potential of TC plantlets.

Site and Soil Preparation

Successful banana production begins with careful field selection and preparation. Ideal conditions include well-drained loamy soil rich in organic matter, a sunny, wind-protected location, and soil pH between 6.0 and 7.5. Pits measuring 0.5 × 0.5 × 0.5 m are prepared and enriched with 10–15 kg of decomposed farmyard manure (FYM), neem cake, and biofertilizers to enhance soil microbial activity. A spacing of 2 m × 2 m is recommended for cultivars like Grand Naine.

Nutrient Management
Banana is a heavy feeder crop requiring substantial quantities of macronutrients and micronutrients. Nitrogen stimulates vegetative growth, phosphorus promotes root development, and potassium enhances fruit filling and sweetness. Micronutrients like calcium, zinc, and boron improve fruit quality and reduce physiological disorders. Integration of biofertilizers and compost sustains long-term soil fertility.

Water and Irrigation Management
Banana plants require consistent moisture but are sensitive to waterlogging. Drip irrigation has emerged as the most efficient system, saving up to 60% of water while providing uniform moisture to the root zone. Fertigation through drip systems ensures precise nutrient delivery. Water-smart practices enhance efficiency.

Integrated Pest and Disease Management (IPM)
Major threats include nematodes, Sigatoka leaf spot, and Fusarium wilt (Fusarium oxysporum f. sp. cubense). Preventive measures include the use of disease-free plantlets, resistant genotypes, and maintaining field hygiene. Biological control using Trichoderma spp. and neem-based products suppresses pathogens naturally.

Flowering, Bunch Development, and Postharvest Management
Flowering typically begins 7–9 months after planting. Covering bunches with perforated blue polythene bags protects them from sunlight and pests. Removing the male bud redirects nutrients, and careful postharvest handling enhances market value.

Intercropping and Ratoon Cropping for Sustainability
Banana cultivation can be made more eco-efficient through intercropping with short-duration crops and ratoon cropping, which uses suckers from the mother plant. Regular nutrient and pest management maintain ratoon productivity.

DISCUSSION

The integration of biotechnological propagation (TC) and scientific agronomy marks a paradigm shift in banana production. It allows scalability, genetic uniformity, and environmental resilience. Future advances like AI-based irrigation and precision pest detection will further bridge the lab–field divide.

CONCLUSION

The combination of tissue culture and integrated agronomic management represents a breakthrough for modern banana cultivation. By merging biotechnology with field precision, banana growers can achieve higher yields, better fruit quality, and long-term ecological sustainability.

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