ABSTRACT

Musa acuminata, commonly known as banana, stands as a botanical cornerstone with its extensive cultivation and diverse contributions to agriculture, nutrition, and economics. The exploration of optimal *in vitro* propagation techniques for *Musa acuminata* has been the focus of this study, particularly through the innovative approach of a liquid culture system. While traditional agar-gelled semi-solid media have been conventionally utilized for plant tissue culture, the associated production costs have prompted a quest for more efficient alternatives.

This investigation embarked on a comprehensive exploration, investigating into variables such as support materials, temporary immersion system, culture vessel types, vessel stopper types and carbon dioxide enrichment to evaluate the feasibility of a liquid culture system for the micropropagation of *Musa acuminata*. The discerning results unveiled that the liquid medium significantly outperforms the conventional semi-solid medium in fostering *in vitro* growth and shoot multiplication of *Musa acuminata*.

The choice of support matrix proved to be a critical factor, with glass beads emerging as the optimal option due to their inert, autoclavable, and reusable characteristics. The incorporation of a temporary immersion approach in the liquid medium showcased notable benefits, facilitating the elongation and multiplication of shoots, accompanied by a considerable increase in leaf area. CO_2 enrichment, particularly when combined with sucrose, emerged as a crucial factor in promoting optimal *in vitro* plant growth, with the liquid medium demonstrating superior performance under CO_2-enriched conditions.

Furthermore, the selection of culture vessels, gelling agent and rooting medium exerted influence over the overall growth and rooting capability of *Musa acuminata*. The liquid culture system consistently yielded proficient plants with enhanced characteristics and increased survival rates during the *in vitro* hardening process. Scanning electron microscopy and histological examinations provided insights into structural variations in leaf surface structures and root tissues, hinting at the potential for accelerated acclimatization of plants cultivated in a liquid medium.

Chlorophyll fluorescence parameters indicated a temporary stress during *in vitro* cultivation, with minimal impact on the overall photosynthetic efficiency of *Musa*

acuminata. To ascertain the genetic stability of the propagated plants, Random Amplified Polymorphic DNA (RAPD) analysis was carried out, revealing the stability of micropropagules and plantlets across diverse growth conditions. This confirmation of genetic fidelity further solidified the suitability of the liquid culture system for large-scale cultivation.

In conclusion, the adoption of a liquid culture system, combined with alterations in growth conditions, presents a cost-effective and efficient alternative to traditional agar-gelled semi-solid media for *Musa acuminata* micropropagation. The findings of this study offer valuable insights into the optimization of *in vitro* conditions, not only enhancing plant growth and morpho-physiological development but also ensuring genetic stability. These revelations pave the way for novel prospects in economically efficient large-scale cultivation of bananas, contributing to the sustainable advancement of agriculture and horticulture practices.