Efficiency of the Production System for Pre-Sprouted Sugarcane Seedlings in an Indoor Environment

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Objectives

The present study evaluated the efficiency of producing pre-sprouted sugarcane seedlings under controlled indoor conditions using artificial lighting. The main objective was to compare a reduced production cycle of 30 days with conventional nursery systems operating at 50 and 70 days. Additionally, the study aimed to determine whether the shortened cycle would affect seedling quality, root development, field establishment, and final agricultural productivity.

Methods and Procedures

The experiments were conducted at the IAC Sugarcane Center, located in Ribeirão Preto, São Paulo, Brazil, and were structured in two sequential stages to ensure a comprehensive evaluation.

In the first stage, seedlings were cultivated in an indoor environment using trays composed of 50 cells, each filled with 140 mL of substrate. A completely randomized design was adopted, with 150 experimental units per treatment. The evaluated treatments consisted of T70 (70-day seedlings), T50 (50-day seedlings), and T30 (30-day seedlings produced under indoor conditions). Root dry mass was used as a primary indicator of seedling vigor and development.

The indoor cultivation system employed full-spectrum LED lighting (60 cm), with a photosynthetic photon flux of 76 μmol s^{-1}. Environmental conditions were carefully controlled, maintaining a temperature of 32 °C and relative humidity of 80%, ensuring optimal growth conditions throughout the production cycle.

In the second stage, seedlings were transplanted to the field under a randomized block design. The experiment consisted of 15 plots, each containing five rows measuring 8 m in length, with 1.5 m spacing between rows and 0.6 m between plants, totaling 60 m^2 per experimental unit. A spacing of 3 m between plots was maintained to avoid interference. The cultivar IAC SP95-5000 was used, and plant development was monitored over a period of 180 days.

The evaluated variables included tillering and the Excess Green Index (ExG), obtained from aerial imagery, allowing for a quantitative assessment of canopy development and vegetation coverage over time.

Results

The results obtained for root dry mass were 0.72 g plant^{-1} for T70, 0.83 g plant^{-1} for T50, and 0.33 g plant^{-1} for T30. No statistically significant differences were observed between T70 and T50 treatments according to Tukey's test at a 5% probability level.

Following field transplantation, all treatments exhibited similar patterns of development and establishment over the 180-day evaluation period. Agricultural productivity reached 133 t ha^{-1} for T70, 140 t ha^{-1} for T50, and 131 t ha^{-1} for T30, indicating that the reduced production cycle did not negatively impact yield.

Total Recoverable Sugar (ATR) values were also consistent across treatments, with 136.83 kg t^{-1} for T70, 139.41 kg t^{-1} for T50, and 138.30 kg t^{-1} for T30, showing no significant differences.

Furthermore, the indoor production system demonstrated a 133.33% increase in efficiency in terms of space and time utilization. The production cycle was reduced by approximately 2.33 times, enabling faster turnover without compromising seedling quality, crop performance, or technological attributes.

Conclusions

The indoor production system for pre-sprouted sugarcane seedlings proved to be highly efficient, allowing a substantial reduction in production time while maintaining agronomic performance. Seedlings produced within a 30-day cycle showed equivalent development, field establishment, and productivity when compared to those produced in traditional 50- and 70-day systems. Therefore, the adoption of controlled-environment indoor systems represents a viable and advantageous alternative for optimizing seedling production, improving resource use efficiency, and increasing overall system productivity without the need for expanding cultivated areas.